The Dock and Harbour Authority

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Editorial Comments

The Port of Ghent.

Ghent owes its importance as a maritime port to the sea-canal which leads to the Scheldt Estuary at Terneuzen, while its development as an industrial centre, is due to its geographical position at the junction of two important rivers, and its rail and road connections with many manufacturing towns of Western Europe.

In the Middle Ages, Flanders was the chief manufacturing country of northern Europe, and Ghent and Bruges, its largest towns, were the best customers England had for its produce. At that period of history, England was mainly an agricultural country, and the chief export was wool which was sent to Flanders to be woven into cloth by the Flemish manufacturers. The desire to preserve these British interests influenced Edward III in his foreign policy, and was a contributory cause to the Hundred Years War with France, which sought domination of Flanders. Ghent is also linked with England in another respect—the third son of Edward III, John, was born at Ghent (or Gaunt) and is an ancestor of the present Queen of England.

It is interesting to note that while wool is still prominent, as an import, the textile trade of the city has developed with cotton and flax as the principal raw materials.

The steady development of Ghent, both industrially and as a sea and inland port, and details of the post-war improvement and extension schemes which are in hand, form the subject of our leading article for this issue. An important major development is the proposed widening and deepening of the existing sea-canal and the construction of a new sea-lock with a depth of 41-ft. as against the depth of 27-ft. 3-in. of the existing West Lock. This canal is open night and day and is lighted on both sides, navigation being entirely free.

Ghent itself is a tideless, fresh-water port with seven miles of deep water quays, having depths of water varying from 18-ft. in the inner Trade Dock to 30-ft. to 40-ft. in the Ghent Dock and Sifferdock respectively. The latter, which was partially cut and equipped prior to the recent war, has been extended by an additional length of quay wall, and when finally completed and linked up with roads and railways, will form a valuable extension of the port facilities. Other works in hand include the widening of the entrance channel to the Great Dock, and the construction in front of the existing mass concrete wall of a new quay, some 2,300 yards long.

Both these new quay walls are built on the reinforced concrete platform principle, which is the type well suited and deservedly popular, both on the Continent and elsewhere, for use in ground consisting largely of sand. The two designs contain some interesting aspects, particularly the system of transferring, in the Sifferdock quay wall, the pull of mooring ropes to the platform by a tie-beam and an independent buttress.

Another feature of the port is the large number of quay and other cranes, all electrically operated, with which it is equipped, and readers will note the type of level luffing 2½- and 5-ton portal cranes which are under construction for the handling of general cargo to the quay, river barges, and sheds 115-ft. behind the quay edge.

The importation of timber in Ghent is a prominent trade, and timber storage sheds destroyed during the war are being replaced by reinforced concrete buildings with pre-stressed concrete roofs, the height of which, however, judging from British standards, appear to be somewhat low.

The fully automatically controlled sub-station which provides direct current at 450 volts, through mercury-arc rectifiers, is of the most modern design, and a description is given of some interesting innovations, in so far as applied to dock working, which have been introduced.

In the course of his article, our contributor has emphasised that the layout of the docks, railways and roads, the accommodation afforded by the quays and sheds, and the provision of ample lifting appliances, have all been conceived with one object—to increase the speed of cargo handling and ship turn-round.

The role of a modern port, planning not only for its own economic interests, but also for those of the localities and industrial areas it serves, must always be not only to keep abreast of requirements, but also in advance of them. This, the Port of Ghent is in process of accomplishing, and the continued efficiency and prosperity of the city and port therefore seems assured.

The St. Lawrence Seaway.

The announcement that hearings have been reopened in Washington, by the Senate Foreign Relations Committee, of further legislative proposals to enable the United States of America, jointly with Canada, to carry out the St. Lawrence Seaway Project, again calls attention to this important matter. The new legislation, it is understood, takes account of the suggestions and criticisms that were made, last Spring, before the House Public Works Committee during the course of extensive hearings on the same subject.

Editorial Comments—continued

The Canadian Parliament has already approved a measure to set up a St. Lawrence Seaway Authority for the purpose of building and operating the navigational part of the Seaway. It has also approved a Bill authorising an agreement between the Canadian Federal Government and the Provincial Government of Ontario, which provides that Ontario will develop, with the State of New York, the hydro-electric power resources of the International Rapids Section. Both these measures are based upon the assumption that Canada will proceed with the Seaway part of the Project alone, a date in 1953 being given for commencement of the work in the field, but they leave the way open for participation by the United States.

As mentioned in our issue for January last, it seems clear that the Canadian Government anticipates no difficulty in reaching agreement with the State of New York in respect to the questions of the level and diversion of the waters of the St. Lawrence River, on the basis, presumably, that there has been little objection in the U.S.A. regarding the hydro-electric part of the scheme.

It is not revealed in what manner the various differences of opinion as to the depths and widths of the proposed channel and locks have been resolved, nor what steps, if any, have been taken to investigate certain schemes for rendering the Seaway free of ice and navigable at all periods of the year.

According to American newspapers, President Truman has renewed his appeal to Congress for approval of the Seaway and Power Project, and there also seems to have been, in some quarters of the United States, a change to a more favourable opinion of the Project as the issues have become clarified. In his appeal to Congress, Mr. Truman added that he realised that there was considerable opposition on the part of certain railroad and port interests in the country, but he pointed out that there was no longer any question of whether the Seaway should be built.

It is possible that the present position, brought about by Canada's independent and possibly unforeseen action, may have put Congress in an embarrassing position, for if the new channel is built on the Canadian side of the River, presumably, no consent on the part of the United States would be needed for this part of the Project.

U.S. shipping interests on the St. Lawrence are of considerable importance and provided adequate facilities are made available, they will undoubtedly increase still further in connection with the shipping of iron ore from the Labrador area. Consequently, if Canada proceeds alone with the navigation part of the Project, Americans may find themselves paying, through tolls on shipping, a large part of the cost, without acquiring any advantages of joint ownership and control, or a voice in deciding what the tolls should be. Obviously it will not be in the best interests of either country for such a situation to arise, which might even cause the St. Lawrence to become a matter of contention when it should be a means of promoting solidarity

While the plan may be eventually approved by the Senate, it is possible that it will be again defeated in the House of Representatives, due to the opposition of certain port, transport and other interests. It may be, therefore, that Canada will have to carry out the Project alone, which will indeed be regrettable.

The Oil Pollution Nuisance.

A matter recently discussed in the House of Commons concerns oil pollution in coastal waters. This subject, which is constantly being mentioned in the daily press, has also been frequently referred to in these columns, and as recently as last June, we printed a specially contributed article which gave details of the international legislation already in force, the harmful effects of oil pollution, suggested remedies, present investigations and future plans.

When questioned in Parliament a short time ago, the Minister of Transport said that analysis of samples washed ashore last year on the Cornish coast suggested that the oil had been in the sea for a considerable time; it may have come from vessels sunk during the war, or it may have drifted in from many miles out at sea. His department was collecting information from coastal authorities and other interests, and when this was collated he would consider what useful steps he could take to prevent the nuisance.

It is encouraging to learn that experiments are being carried out by oil and shipping companies, harbour authorities and other interested parties in an endeavour to find an answer to the problem, and although the progress made so far appears to be slow, nevertheless, the difficulties are not insoluble, and the research studies recommended by the United Nations last year, if vigorously pursued, are likely to prove successful. It is to be hoped that legislation to enable drastic action to be taken will then be agreed internationally.

Distortion of Scales in River Models.

In the recently issued Annual Report for 1951 of the Liverpool Observatory and Tidal Institute, Dr. A. T. Doodson, the Director, calls attention to a large model of the River Elbe which he inspected last Summer when on a visit to Europe. This model illustrates his contention that with distorted river models special steps must be taken to exaggerate the water friction if hydraulic similarity is to be preserved. In view of the growing importance of such models in river control, Dr. Doodson's views should receive earnest consideration.

Our readers will remember that Dr. H. Chatley indicated similar ideas some time ago in the columns of this Journal. Some distortion of models is inevitable for practical reasons, but if it is carried to the extreme, there is grave doubt whether they serve much useful purpose, except to indicate the general trend of the currents.

Carriage of Dangerous Goods by Sea.

The report of the Departmental Committee on the carriage of dangerous goods and explosives in ships was published last month (H.M. Stationery Office, price 15s.) and is now being studied by the Ministry of Transport. The Committee, which was drawn from representatives of the shipping and chemical industries and the appropriate government departments, was set up in June, 1946, by Mr. Alfred Barnes, then Minister of Transport, under the chairmanship of Dr. H. E. Watts, H.M. Chief Inspector of Explosives.

Problems concerning the carriage of dangerous cargoes were studied and reported on before the First World War, since when, another Committee previously to the one mentioned above was appointed in 1930 and issued a report in March, 1933. This Committee was asked to consider the then existing Board of Trade Memorandum on the carriage of dangerous goods in ships and advise what alterations were desirable, particularly having regard to the provisions of the International Convention of Safety of Life at Sea, 1929, which provided for the making of regulations on the subject to have international effect.

The last International Safety Convention, held in 1948, also recommended that the subject should again be studied with the object of drafting necessary regulations, including, if practicable, marking up distinct symbols or designs to distinguish the kind of danger presented by particular goods. This recommendation has been carried out by the present Committee and the rules it has drawn up are likely to form the basis of an international code.

The new report and appendices set out the Committee's recommendations for the packing, stowage and labelling of over 600 dangerous substances and for the carriage of explosives. With regard to the problem of implementing the recommendations, it is pointed out that the rules drafted by their predecessors, although accepted in the main by the Board of Trade, were not given statutory sanction, although they were accepted voluntarily by British shipowners. Now, under the International Convention of 1948, the United Kingdom has accepted the obligation to issue detailed rules which should be statutory. It is important, therefore, that they should be made as flexible as possible so that they do not hamper developments nor unnecessarily restrict trade.

It is satisfactory to observe that the report of the 1930 Committee has been widely followed since 1933 by British commercial interests, so that no great changes in British practice are likely to become necessary.

The Port of Ghent

Improvement and Extension Works In Hand

By Mr. A. VERMEULEN, Chief Engineer,
(Director of the Technical Services of the Port).

The proximity of the sea promoted the commercial development of the town of Ghent, founded about a thousand years ago at the confluence of the Rivers Scheldt and Lys.

A sea canal from Terneuzen, cut in 1827, brought Ghent within easy distance (32 miles) from the sea. This modern, well equipped, single-locked and tideless sea canal provided industrial Ghent with a first-class seaport.

The industrial activity of Ghent comprises four main branches: timber, textile, metal and chemical products.

Wool, flax, jute, synthetic staple and especially cotton ensures work to thousands of craftsmen. The metal group embraces mechanical and motor engineering, wire mills, nail factories, foundries, shipyards, shops for electrical supplies and many others. Plants manufacturing chemicals and fertilizers, established along the left bank of the Terneuzen canal and the Scheldt, produce many kinds of mineral acids and by products such as dyes, pigments, synthetic rubber, glues, gelatines, mineral oils, etc. Numerous timber and saw mills employ 2,000 workers.

In 1914, fourteen industries were established within the port area; now there are more than 70. The tendency of industry to settle near sea canals and ports, finds its main cause in the resulting saving of transport charges, and explains the development of the industrial function of the port of Ghent: it offers the most advantageous conditions.

The same advantages have enhanced the regional function of the port.

Owing to its ideal geographical location, the port facilitates the distribution of goods through an unequalled network of inland waterways, railways and highways. The vast hinterland thus served, includes not only the Belgian-Luxemburg Economic Union, but also Northern France to beyond Paris, Eastern France, Alsace-Lorraine, Western Germany, Switzerland, part of Czechoslovakia, Austria and Northern Italy. Paris, as well as Bale, the Ruhr—as well as the Sarre areas are served by Ghent, it being at the same time a first-class seaport, a busy Rhine port and a flourishing inland port.

In order to handle the considerable basic freight from the vast network of industrial establishments in its vicinity and in Western Europe, the port of Ghent has specialised in developing the extra speedy handling of raw materials and finished products at a minimum cost. The layout of the docks, the accommodation offered by quays and sheds and the powerful lifting appliances. all were conceived with one object: speed.

The quick advance of the allied forces in 1944 ensured the preservation of the maritime installations from total destruction. This justified the hope of a speedy recovery of the port activity, and the intensive exploitation of the port during the period of liberation was greatly appreciated by the Allied Military Authorities, who declared : "Ghent maintained a ship discharge average of 962 dw. tons per day and per ship for deep sea vessels throughout the month of April 1945. This is the highest output per ship ever attained in the European theatre of operations, including the ports of Britain, the Mediterranean, of France and of Belgium. In fact, it is believed no other port in World War II in any other war theatre has even performed so well."

The hoisting plant consists of more than 150 cranes with a lifting capacity varying from 2½ to 15 tons, floating cranes and 15 loading bridges from 2½ to 10 tons. All cranes except the floating units are electrically driven and travel along the quays, and most of them are equipped with movable jibs. The total length of quays, banks and wharves is 20 miles, with a water surface of 556 acres. Floor space in covered sheds and warehouses totals nearly 40 acres, and storage space for 500,000 bales of cotton is available.

The harbour of Ghent is thus one of the leading industrial ports of Western Europe, designed for the most economical handling and transhipment of heavy bulk cargoes, whether for export or for import. Ghent being an import transit port, particular attention is given to the modernisation of the communication lines connecting it to the vast hinterland.

Moreover Ghent is the national industrial port, and a general plan of extension and modernisation has been drawn up in order to amplify the industrialisation of the port zone. It comprises: the construction of a new sea lock in Terneuzen of the following dimensions: length 984-ft., width 115-ft. depth 41-ft., including the widening of the canal to 475-ft. on Dutch territory, and 656-ft. on Belgian territory, and the straightening of it in order to avoid bends and towns: together with the replacement of the existing bridges by tunnels or electrically propelled ferry boats.

Complete industrialisation of the right bank of the canal is also planned. A zone of about 8¾ miles long, and from 820 to 1,200 yards wide, covering more than 3,100 acres and served by a double railway link and a 115-ft. wide road, will supply ready cleared sites to concerns, who plan to establish themselves in this area. This zone is the best industrial site in Belgium, and consists of flat and open country, free of any natural barrier. The composition of the soil makes heavy foundations for construction projects possible, and the extent of the available land allows the effective isolation of industries.

Heavy industry depends on the import of raw materials such as ores, mineral oils, wood, coal, coke and others. The mooring, loading or discharging of great ocean vessels is possible at all times, making the use of the port highly attractive. Morover limited distances, makes transhipments unnecessary, and ample storage space is to be found along the Ghent Terneuzen canal zone.

The proximity of a highly concentrated industrial centre served by a number of important highways, a crossroad of European inland waterways and the most dense railway system in Europe, makes the port of Ghent the most economical. Manifold and varied established industries complement each other in the provision of electric power stations and coking plants, which, with the chemical products manufactured in the locality greatly benefit new industries.

The leading town of the province, the city of Ghent, has highly diversified industries and flourishing trade markets, and the proximity of an efficient port enhances both the import and export possibilities of all industrial products.

Considering the economic importance of the port of Ghent, it is interesting to examine the post-war efforts of the authorities in regard to the modernisation and extension of the port, improvements which will still further augment the services which are available and permit a growing increase of its industrial and transport facilities.

Reconstruction of the Port Arthur Quaywall.

The importance of the Port Arthur quay (see Fig. 1) is clearly illustrated by the following figures :

Length	... 2,290 yards
Number of cranes ...	... 42
Total covered storage space	642,372 sq. ft.
Total cubic capacity of the covered storage space	... 8,157,765 cu. ft.
Railway tracks ...	... 3

The quay was built in 1903 and consists mainly of a massive concrete wall, the last stretch being pile-constructed; the water depth at the foot of the quay being 19-ft. 6-in., and 26-ft. 2-in. at 40-ft. from the wall.

Its stability was severely undermined by the explosion of several bombs immediately at the foot of the wall and on the backfill of the quay. Considerable and fatal cavities were thus caused, not to mention the abnormal forces developed by the impact of the bombs. Execessive dredging, early in 1945. caused depths of 32-ft. 6-in. and more; consequently, the wall started to list, and subsided in places between 6-in. and 9-in. and sliding forward by 3-ft. 4-in. in places, causing continuous danger. Some preventative works were undertaken, but only the reconstruction of the wall could effect a satisfactory solution.

The Port of Ghent—continued

View of Port Facilities and Shipping, Ghent.

With this in mind, extensive soil borings and depth soundings were made in the course of 1949, to enable the port services to calculate the ground pressure which the wall would have to carry.

These tests consisted of :

(a) 15 depth soundings behind the existing wall to the (–29-ft. 6-in.) and (–45-ft. 11-in.) level, according to resistance;

(b) 5 depth soundings in front of the existing wall, that is to say, in the dock itself, to the (–36-ft. 1-in.) and (–42-ft. 8-in.) level, according to the position of the strata, which limit the penetrating capacity of the apparatus.

The waterdepth along the new wall has been fixed at 28-ft. 8-in. The strip situated between 32-ft. 9-in. and 7-ft. 6-in. of the frontside of the wall is designed to carry a load of 512 lbs. per square foot, whilst the remaining surface at 32-ft. 9-in. or more behind the apron front will be able to carry 2,047 lbs. per square foot. Bollards and mooring bitts are constructed to support a pull of 75 tons and 10 tons respectively. The pressure exercised on the wall by moored vessels can reach 1,024 lbs. per square foot and is mainly absorbed by the reinforced concrete deck. The live load of cranes and railway rolling stock have also been considered.

Public tenders were invited for the work, the data supplied enabling the contractors to prepare a project and estimate, with the object of taking advantage of new methods and types of plant and equipment and the personnel trained in their operation.

The cross-section of the wall can be described as follows: four rows of concrete piles, and a row of steel sheetpiling at the waterfront carry a reinforced concrete deck, 41-ft. 10-in. wide and 2-ft. 8-in. thick. This construction is built at the waterside of the existing wall. The space between the front of this last wall and the afore-mentioned curtain of sheetpiling is earthfilled up to the concrete platform. (See Fig. 2.)

The reconstruction works have been studied in ten separate sections, according to the type and the position of the existing wall, and taking into consideration the variations in the earth-strata.

Expansion joints placed every 130-ft., have been provided in view of the shrinking of the concrete by temperature variations, and of the construction itself.

The construction yard consists of four main sub-divisions:

I. An area for stacking and bending the reinforcement steel to be used in the platform and wall. This yard was originally situated at the northern section of the wall, and is moved southwards as work progresses.

II. A preparation yard where gravel, sand, cement and other materials (sheetpiling, rails ladders, bollards, mooring bitts, etc.) are stacked in silos and sheds.

Two grab cranes on rails transfer the gravel and the sand from the silos to loading funnels placed above a Decauville-track and provided with automatic batching equipment. From this point, trains of ten wagons each, each wagon containing a complete and correctly batched dry mixture, leave for the 310 gallon concrete mixers. The elements of the front apron are prefabricated and stacked at the same wharf. A separate area for the preparation of the road metal is also provided.

III. The manufacturing of the concrete piles is done at a third yard. The first section supplies the reinforcement ready to be placed in the shuttering and the concrete is poured into the metal casings, the piles being lifted 48 hours after manufacture and stacked by means of a 12-ton swinging bridge crane. This same crane places the R.C. piles on bogies in order to transport them to the pile-driving site, according to the requirements.

IV. The main Quay. The works have been started at the Northern end and are so arranged that the activities follow each other regularly, and that 130-ft. stretches are completely finished weekly.

The main activities on the wharf are:

A pile-driver on pontoons drives a double row of 60-ft. wooden piles. Placed on the waterside, these support a rail track which will be used for the exploitation of the further mentioned machinery.

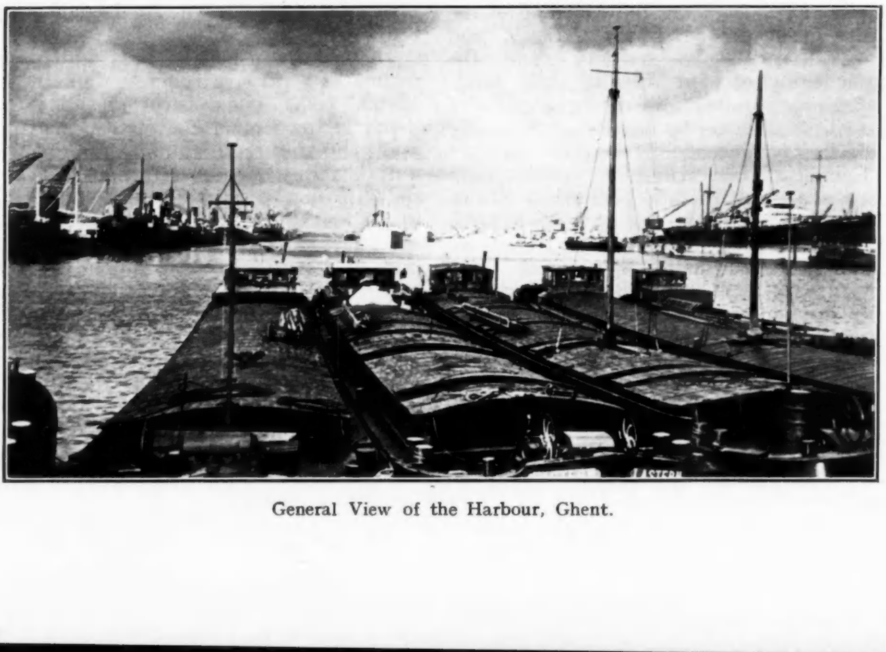
A tracked diesel crane removes the copings of the existing wall and proceeds with the excavations behind it.

The part of the existing wall which is not required is then demolished.

The first universal pile-driving engine, resting on a 82-ft. bridge, drives the sheetpiling of the new wall.

A second universal pile-driver, drives the first and third row of piles.

A 100-ft. high tower-crane with a capa-



General View of the Harbour, Ghent.

The Port of Ghent—continued

city of 12 tons at 28-ft. reach, presents the piles, at the required slant, to the pile-drivers.

A third pile driver drives the second and fourth rows of piles.

Two concrete beams are now constructed, the first partly under water on the top of the sheetpiling, the second on the second and third pilerows after removal of the pilecaps. The concrete mixers on this job are fed from Yard II and a bridge with Decauville track and wagons allows the concrete to be poured on the required surface.

The space between the old wall and the row of sheet-piling filled hydraulically.

The reinforcement of the deck is put into position after laying down a preliminary layer of concrete.

A concrete mixer supplies the concrete for the platform deck, the dry mixture coming from Yard II. The same bridge is also used for concreting the wall.

The apron elements are placed into position and firmly concreted.

The shuttering of the wall is placed and provided with a groove for the electrical current rail of the port cranes.

The sewers are placed and connected to the drain pipes laid down in gravel and sand on the R.C. platform. These are provided in order to collect seepage water.

The space between the walls and above the R.C. deck is sand-filled. The sand is vibrated to a maximum density in order to avoid later subsidence.

The landside crane-rail and the railway tracks are laid down; the road concrete is poured and the stone pavement and the "stelcon" plates are laid.

The value of the equipment already used is sufficient to illustrate the importance of the reconstruction works of the Port-Arthur quaywall. Work was commenced in the summer of 1950, and is anticipated to be finished towards the end of 1952. The total cost of these works is estimated at approximately £2,145,000 and the following materials will be used:

Earth filling ...	327,000	cu. yds.
Metal sheet piling ...	6,000	tons.
Concrete piles ...	4,500	pieces.
Reinforcement steel	6,000	tons.
Reinforcement concrete ...	40,000	cu. yds.
Paving-stones ...	215,200	sq. ft.
Concrete flooring ...	538,000	sq. ft.

The Sifferdock.

This dock was already partly cut before the second world war and equipped, with 618 yards of quay. After completion it will be 2,624 yards long, 656-ft. wide and able to receive vessels of 40-ft. draft. Work on a new 570 yards stretch was commenced in December, 1948, and entirely finished in July, 1950.

The total cost amounted to £431,372.

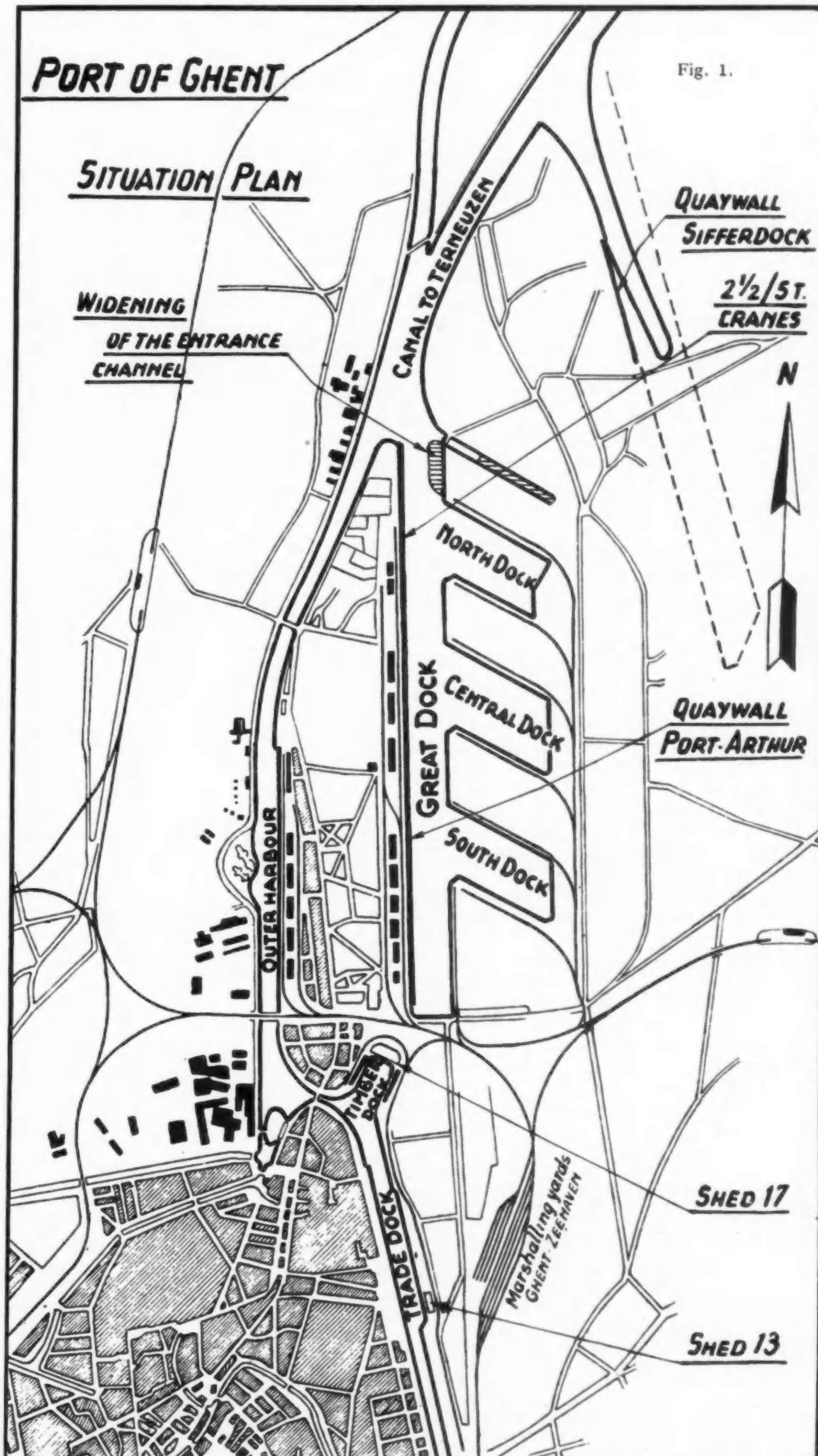
The choice of this type of new quay-wall has been based on the three following characteristics:

The required waterdepth of 41-ft.

The very important design loading of 5,120 lbs. per square foot on the rear of the quay.

The presence of a layer of clay with a thickness varying between 13-ft. 3-in. and 26-ft. 6-in.

A massive wall built in the open or even under compressed air, was not to be con-



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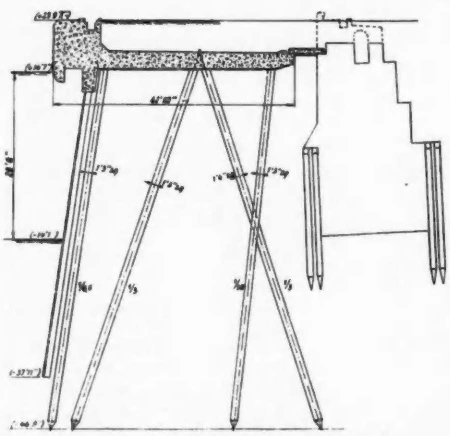


Fig. 2. Cross-section Port Arthur Quay Wall Reconstruction. Length of wall 2,300 yards.

sidered as such a wall would require its foundations to be very deep under the dock level, hence the cost would be prohibitive. Piled construction was therefore indicated.

The level of the reinforced concrete deck has been calculated taking into consideration the following factors:

(a) It had to be placed deep enough to disperse the vertical superimposed point line loads, so that these loads coupled with the external pressures, did not require an excessive number of piles.

(b) It required to be placed as high as possible in order to minimise excavations and drainage.

(c) To reduce the pile lengths to reasonable proportions necessitated a reinforced concrete deck situated as low as possible.

After close consideration it was decided to place the level of the underside of the deck at (+8-in.) above ordnance datum. The wall carries mobile superimposed maximum loads of 280 tons per foot for cranes and 480 tons per foot for the transporter bridges.

The cranes can follow each other in unlimited numbers and in all possible combinations. Consequently the area comprised between parallels situated 6-ft. 6-in. behind the frontside of the wall and 65-ft. 6-in. behind this front is designed to carry a load of 1,024 lbs. per square foot. The area 65-ft. 6-in. and more, behind the front-apron is to carry a load of 5,120 lbs. per square foot.

The pull of mooring ropes per bollard was taken as a tractive force of 75 tons, applied 8-in. above the level of the coping, either horizontally or at a 70° angle. The distance between bollards is the same as for the Port-Arthur quaywall, namely 65-ft. 8-in. Mooring bitts are placed at 32-ft. 10-in. intervals and can support a 10-ton tractive force.

An evenly distributed horizontal mooring thrust of 3,362 lbs./ft. at the (+15-ft. 9-in.) level on the protective fender was provided for.

In designing the groove for the electric current supply, the following requirements, besides the ground pressure had to be considered.

(1) a vertical wheel pressure of 4 tons;

(2) the mobile surcharge loads mentioned above;

(3) a horizontal, outwards directed and evenly distributed force of 372 lbs./ft. applying 2-ft. 4-in. above the bottom of the groove.

Depth soundings and earth borings on the site proved the presence of three main earth layers: a layer of fine sand, loamy in places; a layer of clay varying between 13-ft. 3-in. and 26-ft. 6-in., with the top-level between (−9-ft. 10-in.) and (−16-ft. 5-in.) below ordnance datum; finally a layer of fine closely packed sand, strongly calcareous.

This last layer gave resistance values above 1,414 lbs./sq. inch at the (−39-ft. 4-in.) level (see Fig. 3).

As a guide to calculations the following soil properties have been accepted:

Nature of underlayers	Specific weight	Inner friction angle	Cohension
Dry sand ...	1,6 T/m3	30°	0
Wet sand ...	1 T/m3	30°	0
Wet clay ...	1 T/m3	0	2

The groundwater level was taken to be at (+17-ft. 10-in.) or 3-ft. 4-in. below the deck level.

The new stretch of quay has a length of 1,706-ft. and is connected to the northern end of the existing quaywall. The level of the quay surface varies between (+25-ft. 6-in.) at the northern and (+23-ft. 4-in.) at the southern end. The alignment of the new quay wall is at approximately 1° to the existing one. Expansion joints divide the quay into 13 parts of 131-ft. each, in order to provide for the expansion of the concrete and the construction. Lengthwise the wall consists of two parts, a first section of 525-ft. on the side of the existing wall, and a second section of 1,181-ft. on the northern end; this division became necessary owing to the varying thickness and level of the clay layer. Both parts have been calculated separately.

In cross-section the wall can be represented as follows: a 49-ft. 2-in. wide reinforced concrete platform carries a massive concrete wall and is supported by eight rows of piles.

The earth under the platform is retained on the waterside by steel sheet piling. The underside of the deck is placed at the (+8-in.) level and is 4-ft. 5-in. thick for the 525-ft. section and 5-ft. 1-in. for the 1,181-ft. section (see Fig. 4).

The mass concrete wall is 7-ft. 7-in. wide at the top and 10-ft. 10-in. at the base, a reinforced anchoring beam joining the wall to the platform.

The expansion joints of the wall and the platform are dented in such a way that the upwards, as well as horizontal movements of two neighbouring sections are interdependent.

The reinforced concrete piles are pre-cast and of a 16-in. x 16-in. section. Two rows of vertical piles are driven on the waterside, at the rearside four rows of backwards raked strutpiles with a 1 in 3 inclination. The piles are driven approximately 3-ft. 4-in. into the tightly packed sand layer situated between the (−39-ft. 4-in.) and (−45-ft. 11-in.) level. The steel sheet piling is cast into the R.C. platform up to 3-ft. 4-in. and strengthened in this particular place. It reaches the (−46-ft. 11-in.) and (−51-ft. 2-in.) levels for the southern and the northern part respectively. A special sheet pile has been driven at the southern end of the sheet piling in order to facilitate a junction when extending the quaywall.

The influences of the surcharges, the water- and the earth-pressures are calculated :

on an assumed vertical plane at the rear of the R.C. platform;

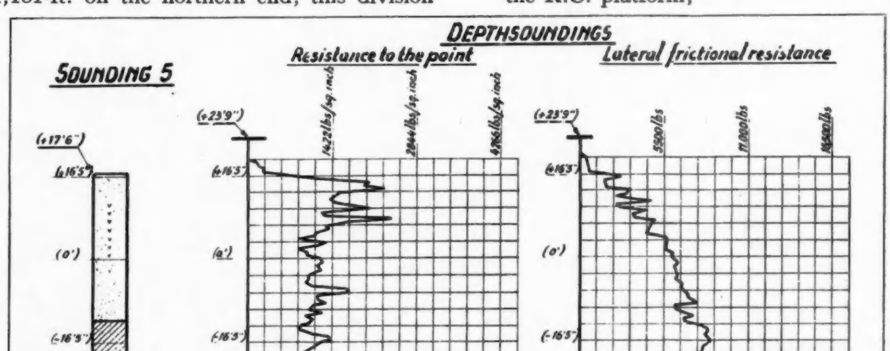
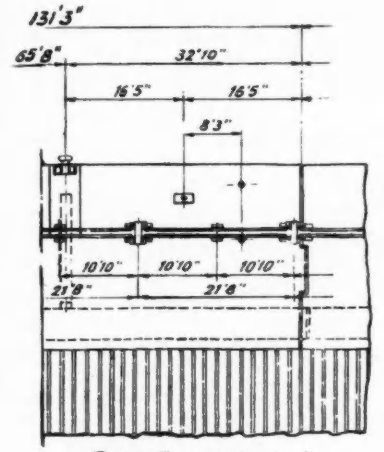
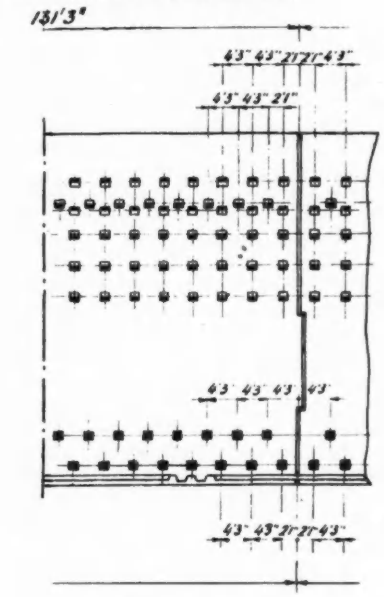


Fig. 3.

The Port of Ghent—continued



PART ELEVATION

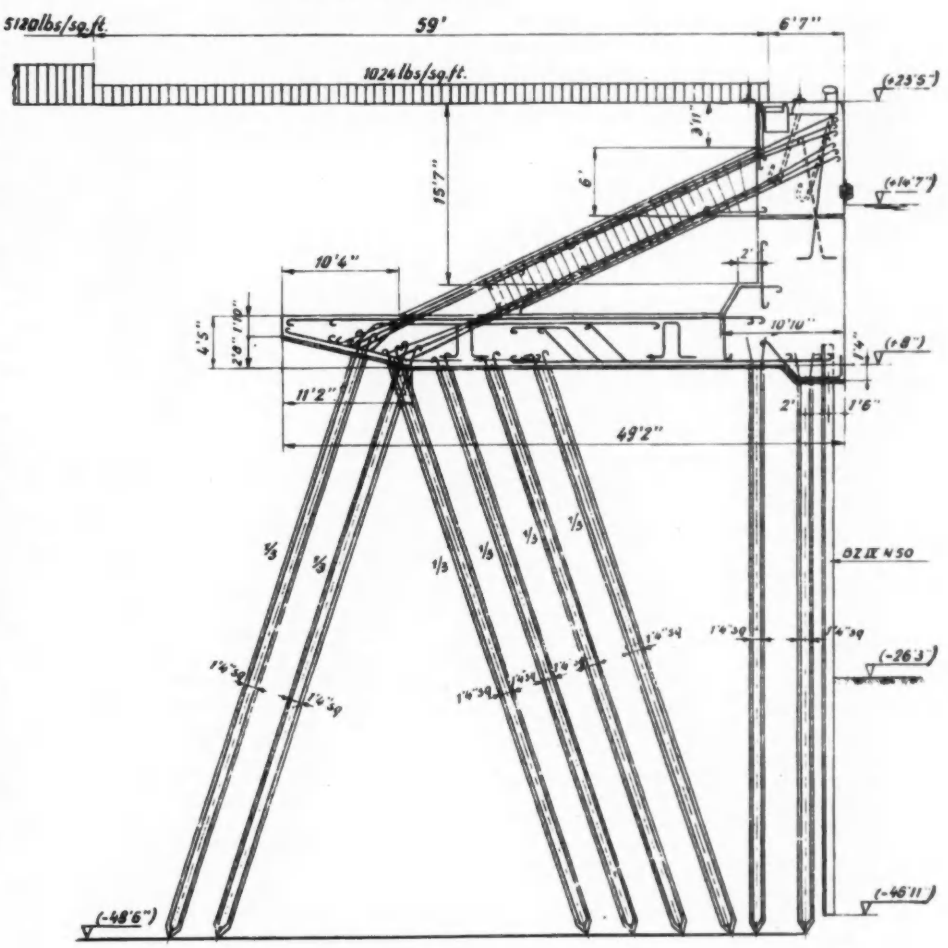


PART PILING PLAN

QUAYWALL SIFFERDOCK

Fig. 4.

Cross section



on the rearside of the wall;

on the upper plane of the R.C. platform;

on the steel sheet piling.

The calculations have been based on the new available data for ground and earth mechanics.

Once the above-mentioned influences were established, the pile-loads were calculated according to the method of Nökkentved and this for the two most unfavourable cases, which could present themselves, namely: maximum pressure on the first six piles, and maximum tractive force in the two rear-piles.

The vertical piles have been placed alternately and resist, together with the steel sheet piling, proportionally with their moment of inertia, the bending resulting from the pressures from the R.C. platform. The other piles absorb the pressures originating from the rear-side of the R.C. platform. The steel sheet piles, of the "Belval" type, have been driven sufficiently deep below the dock level to provide a passive ground-pressure, which can resist the pressures from the rear with adequate security. The wall has been calculated for sustaining the loads originating from the earthfill (earth, water and superimposed loads), and the forces applied from the crane-rail, the mooring bitts and the fenders.

Anchor tie beams transfer the pull of the mooring ropes into the R.C. platform. The tractive force on the bollards is generally, in walls of this type, taken by buttresses. This solution has the drawback that very often cracks appear, due to the fact that buttresses hinder the normal distortion of the wall, and the system cannot be calculated with sufficient precision. This is the reason why it was decided to adopt the following solution: the bollard is anchored in a position of the wall made independent of the rest of the wall by means of joints. This wall-section is connected to the R.C. platform by a reinforced anchor tie beam. This allows the distortion of wall and anchor beam to be independent, thus avoiding cracks.

The R.C. platform has been designed to sustain tension and bending.

The bending which occurs is due to the pile-reactions, the influences of the earth pressures and internal forces on the wall and sheet-piling, whilst the deck is pulled by the horizontal reactions of the wall, the sheet-piling and the piles.

The different load or pressure combinations which may occur at the same time, have been combined for the most unfavourable case, in order to be able to consider the maximum moments and tensile forces.

Examination was made whether adequate safety is available to prevent the depth displacement of the entire construction, that is to say, whether the complete wall with sheet-piling, piles and the earth between and at the rear, possesses sufficient stability not to slide into the direction of the dock according to a curved sliding plane.

The new lamella-method has been employed to calculate this and was applied to check the afore-mentioned earth pressure calculations.

The work was commenced at the extreme

The Port of Ghent—continued

southern end, and was planned on similar lines as for the Port-Arthur quay, that is, in such a manner that excavations, piling-work, concreting of R.C. platform and wall, earth-fillings and finishing follow each other regularly.

The excavations are arranged in three phases: (1) on the dry side, they are executed, up to the (+15-ft. 5-in.) level, by means of three tracked grab-excavators; (2) after draining the ground water, excavating is continued to (+2-ft.) level in order to carry out the pile-driving; (3) finally, excavations between the piles to the level of the underside of the R.C. platform.

In order to give an idea of the work, the following approximate figures may be quoted :

Excavations	3,178,000 cu. ft.
Reinforced concrete piles ...	3,200 pieces.
Steel-sheet piling ...	1,500 tons.
Concrete for R.C. plate	388,500 cu. ft.
Concrete for wall ...	264,900 cu. ft.

The total length of the piles is nearly 31 miles and the quantity of various materials used amounts to more than 70,000 tons.

Lifting Appliances.

The hoisting plant of the port consists of more than 150 units with a lifting capacity varying from 2½ to 15 tons, including one floating crane, 15 transporter bridge cranes and six mono-rails. All cranes, except the floating unit, are electrically driven and travel along the quays. Most of them are equipped with jibs of the level-luffing type. All units are of the portal type, and have two or more railway tracks passing underneath.

A total of 18 cranes was destroyed by war action, including a 40-ton crane and a floating crane. It is intended to replace these by four portal units of 2½ ton to five tons, four 10-ton transporter cranes and several 10-ton grab-cranes.

The four 2½- to 5-ton portal cranes are already under construction and will be installed at the cotton sheds on the Port-Arthur quay. They will be of an entirely different type to any of the cranes now in use.

The lifting capacity is 2½ tons at 118-ft. radius and increases to five tons when gradually reducing the radius to 59-ft. The minimum reach is 28-ft. They are one-cable cranes destined for the handling of general cargo, transhipment into river barges, the serving of sheds situated 115-ft. behind the quay-front, and the handling of goods on the whole width of the quay surface (Fig. 5).

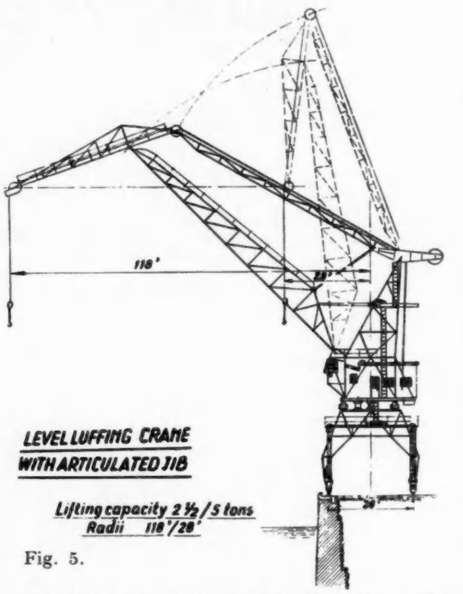


Fig. 5.

The crane jib is of articulated construction, balanced by a counterweight carried at the rear of a rotating balancing arm, which is itself attached to the main linkage system near the apex point above the machinery cabin. When luffing, the jib nose-pulley follows an almost horizontal line, 100-ft. above the quay surface. The floor level of the operating cabin is placed 36-ft. above the quay surface, whilst in any position of the crane a free height of at least 52-ft. 6-in. above the quay edge is allowed.

The cabin is very spacious (29-ft. 6-in. x 10-ft. 10-in.) and entirely of steel plate construction. A glass panelled sliding-door divides the cabin into two distinct parts: the operating room, and the engine-room. A bow window offers a wide and unobstructed view on work and load. The elevated position of the operating room in regard to the engine-room, allows the driver, by simply turning round, visual control over the engine-room machinery.

The portal has a 28-in. gauge and allows two railway tracks between the legs. It rests on four bogies of two wheels each. The maximum reactions per bogie on the quay-wall will be :

(1) working crane with a wind of 6.1 lbs./sq. ft. : 66 T.

(2) out of service crane with a wind of 30.8 lbs./sq. ft. : 81 tons.

The crane itself weighs 140 tons, is constructed in Siemens-Martin steel and mainly riveted. Welded joints are only used for reinforcing highly complicated joints.

Direct current at 440 v. is supplied by underground current-rails.

The hoisting gear is driven by a series-motor of 105 h.p. realising the following hoisting speeds: 5 ton = 230 ft./min.; 2½ ton = 295 ft./min.; with empty hook = 394 ft./min. This motor is steered by a master controller and is electrically braked when lowering the load.

The slewing gear is driven by a motor developing 45 h.p. at 570 revs./min. and 58 h.p. at 990 revs./min. A compound motor has been installed in view of the large size of the turning part and the considerable wind pressure exercised thereon. The luffing mechanism is placed above the cabin and is driven by a 35 h.p. compound motor developing an average horizontal luffing speed of 246 ft./min. Slewing and luffing motions are checked by main current-controllers provided with universal command.

An automatic loadmoment current-breaker is fitted, in order to prevent overloading the crane when hoisting or luffing. It operates in such a way that neither the hoisting motor, nor the luffing-motor, receive any further current as soon as a determined load would be transferred onto an unsafe radius or when a too heavy load would be lifted on a determined reach. Decrease of radius or lowering the load are thus only possible. This has been realised by means of a pulley mounted on an excentric axle. On this pulley the cable exercises a force resultant in function of load and radius (the latter through the inclination of the cable). The pulley is normally kept in balance by a counterweight; when this balance is disturbed by a too heavy lift or too long radius the counterweight is set in motion, causing the disconnecting of the hoisting and luffing motor. The crane travelling gear is mounted on the portal platform, and the driving series motor has a 50 h.p. output and a speed of 311-ft. 6-in. can be developed.

Reconstruction of sheds.

The storage areas in the port of Ghent total 43¾ acres covered, and 162 acres open spaces.

The modernisation of the port installations was kept in mind, when rebuilding the sheds which were destroyed during the recent war. Sheds 13 and 17, already reconstructed during 1949/51, are specially designed for the storing of sawn timber. The discharge, loading and piling of this material requires wide spaces without columns and the pre-stressed concrete technique was found to be the most satisfactory solution (see Fig. 6).

Shed 13 is 345-ft. long and 132-ft. wide and provides 49,335 sq. ft. of covered storage space. The supporting columns are spaced lengthwise every 65-ft. and in width at 49-ft. Only 24 columns have been used, against 96 in the previous construction. The columns of this shed rest on piles: the out-

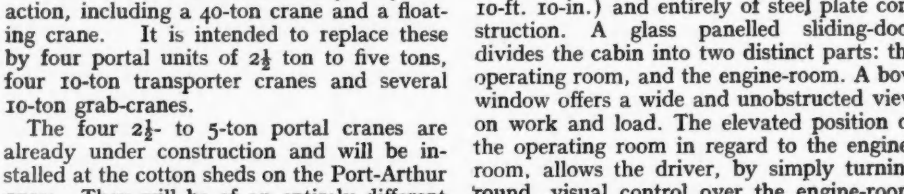


Fig. 6. Cross-section Shed 17, Timber Dock.

The Port of Ghent—continued

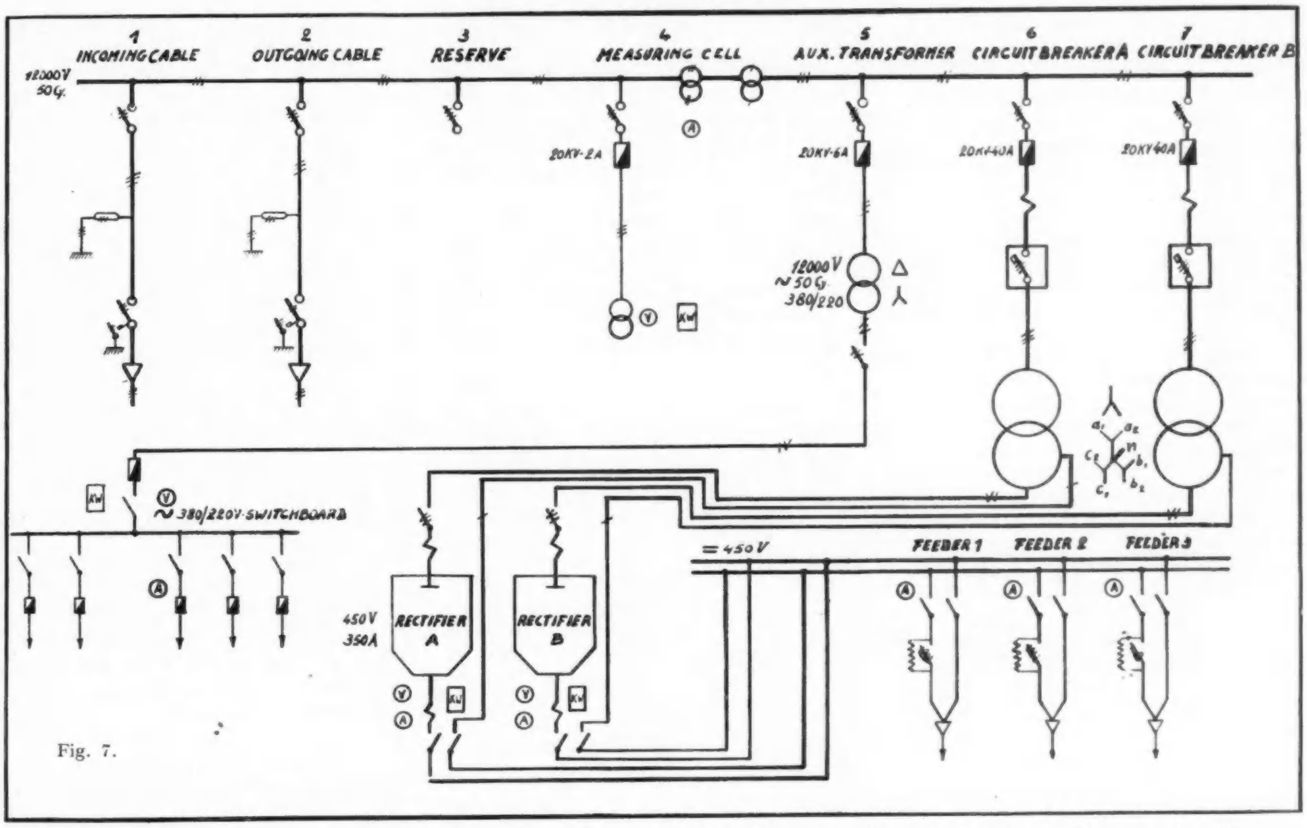


Fig. 7.

ward rows on two, the centre row on three. These piles have been driven to a depth varying between 42-ft. 6-in. and 47-ft. and are of the "Vibro" type. The "Vibro-system" can be summed up as follows: a steel tube, the bottom end being provided with a separate concrete toe or shoe is driven to a depth where sufficient resistance has been obtained; when this depth has been reached, the reinforcing steel is placed inside the tube and the pouring of the concrete is started. Vibration of the concrete is caused through the removal of the tube by means of the pile-hammer, i.e. the tube is knocked out.

The columns carry the ledgers and a contrebeam of reinforced concrete. All beams have expansion-joints.

The lengthwise placed ledgers and the centrebeam are provided with brackets carrying pre-stressed R.C. ledgers, which are placed at 12-ft. intervals.

The roof consists of 1-ft. 7-in. wide concrete slabs (Duyck model) and is covered with watertight rubber roofing.

The flooring has a 9-in. thickness and is composed of a 5-in. foundation of weak concrete and a 3½-in. layer of reinforced concrete.

Shed 17 is 395-ft. long, 128-ft. wide and provides 47,344 sq. ft. of covered storage space. As for shed 13, the pre-stressed technique has been applied and only 19 columns were necessary instead of 100 previously. The columns are supported on three, four or five 26-ft. 6-in. piles. The piles are of the same "Vibro" type and are constructed in reinforced concrete.

When planning this shed, no reinforced ledgers have been included. Pre-stressed head-ledgers rest directly on the columns, whilst the secondary pre-stressed ledgers rest on brackets on the sides of the pre-stressed head-ledgers. The distance between the columns is 63-ft. 11-in.

Short Description and Working of the Automatic Substation with Mercury-Arc Rectifiers.

This substation is aimed to convert three-phased alternating current 12,000 v. 50 cycles into direct current at 450 v., this in order to supply the cranes in use on the "Trade Dock."

Two rectifier sets of 350 amperes are provided, each of them consisting of a feeder-transformer and a glass bulb rectifier. The high voltage equipment of the substation is disposed in seven cells separated by "pierrite" panels. These cells contain the incoming and outgoing cable, a reserve, the measuring, the auxiliary transformer (50 KVA 380/220 v., delta star) designed for auxiliary power supply to the lighting of the building and of the quay sheds; finally the current-breakers for both rectifier sets. These current breakers are of the oil-filled type, fitted with direct relays and are motor-operated. They have a breaking capacity of 250 MVA but are preceded by high tension fuses of 400 MVA breaking capacity, placed in series (see Fig. 7).

All switchgear is rated for 15,000 v. and 350 a. The main transformers of both sets are installed in separate concrete cells; they have at the secondary a six-phased fork connection. The transformers are of the oil-immersed type with natural cooling.

In the low-voltage room the rectifiers are each enclosed in a steel sheet cubicle and provided with six main anodes, two excitations and one ignition anode. Each of the rectifiers is also provided with a heating-apparatus and is fan-cooled. The auxiliary apparatus is placed at the rear of the cubicles.

A ventilating shaft constructed above the rectifier evacuates the warm air and can be closed in cold weather.

The control apparatuses to ensure the automaticity are mounted on switchboards placed on the right-hand side of the main cubicles. Lastly, there are three more cubicles with the necessary apparatus for the feeders to supply D.C. to the quay.

Start, stop and general control of the substation can be ensured manually or automatically. Only the high and low voltage disconnecting switches are exclusively hand-operated. Closing the high voltage circuit causes the operation of all auxiliary apparatus, for instance: the heating, ventilation, ignition and excitation of the rectifiers, etc.

Each set is protected against the following disturbances:

(1) overcurrent at the high voltage circuit-breaker of the set;
(2) undervoltage of the auxiliary 220 volts tension supplied by the auxiliary transformers or the town network;
(3) overcurrent in the D.C. feeders;
(4) overcurrent in the anodes;
(5) lack of ignition, excitation or ventilation;

The Port of Ghent—*continued*

(6) too excessive temperature rises or gas evolution (Buchholz) in the transformer.

When set for automatic operation the protection 1, 3, 4 block the set after three efforts to close the high voltage circuit-breaker. The protection 5 blocks after a determined time, whilst No. 6 blocks immediately. No. 2 does not block at all.

The working of these protections are signalled to the office of the quay-foreman by means of bell and light signals and in the substation itself by means of bell and relays with valet indicating.

When operating automatically the substation can be kept in service continuously or only during a pre-determined time. This last is assured on a time switch.

One of the sets is chosen as the basic, the second operates on reserve.

The sets will start and operate under the following conditions:

(a) the basic one: at the fixed hours of the time switch on condition that the rectifier is at sufficient temperature, if not, a heating resistance is first started;

(b) the reserve set: when the total load of the substation exceeds the pre-determined value at the overcurrent relay and this during a certain time;

(c) each set disconnected for reasons such as overcurrent, under voltage, etc., will automatically be put back into service if the fault is cleared within a certain time.

Under the following circumstances the sets will disconnect automatically:

(a) at the set time of the time switch;

(b) when basic and reserve sets are both working, as a consequence of overloading of the first; the reserve-set will disconnect automatically as soon as the load drops under the fixed value and this during a determined time;

(c) as a result of one of the above-mentioned protections (in case one set block, the disconnecting mentioned in (a) does not occur).

When blocking a rectifier set through a high voltage circuit-breaker the circuit-breaker has to be switched on manually after clearing the fault.

The substation is supplied with three direct current-breakers, operating as follows: as soon as direct current is put on the bars, the high-speed direct current circuit-breaker (corresponding disconnecting switch being closed) will be closed; this occurs when the test which precedes the closing of the breaker indicates the resistance of the feeder to have at least a determined value; if this is not the case the closing of the direct current-breaker does not occur as long as the feeder has not been cleared. After a determined time the fault is signalled by bell signals and a relay with valet indicating.

After the blocking of the high-speed direct current circuit-breaker, the disturbance can be cleared by means of a disconnecting switch in the substation. Afterwards, the direct current breaker has to be put on again through the manual re-closing of the disconnecting switch.

A further two, similarly equipped, electrical substations will be built in the very near future. A first one to be constructed during 1952 will supply the cranes and sheds along the Port-Arthur quay; a second station is already projected to complement the equipment of the Siffer-dock.

The complete execution of the extension and modernisation project as sketched in this article will considerably augment the economic value of the Port of Ghent, and still further develop its industrial and transport facilities.

A Pre-stressed Concrete Dolphin

Following the successful application of pre-stressed concrete to riverside fendering at the Brentford Works of the North Thames Gas Board, further developments are now in hand at the same site, involving the construction of a pre-stressed concrete dolphin.

The fendering works are described in a paper entitled "The application of pre-stressed concrete to structural and building work in the Gas Industry," presented to the Institution of Gas Engineers in November, 1950, extracts from which have been reproduced in the November and December, 1951, issues of this Journal.

The piles used in the construction of the dolphin are exactly similar except for length, to those used for the fenders.

The basis of design is the resilience of pre-stressed concrete under impact forces. The piles are permitted to deflect a limited amount, thus absorbing portion of the initial impact forces, the balance being transmitted from the piles, through rubber buffers to a central mass, the weight of which can be adjusted to suit the magnitude of the impact forces anticipated.

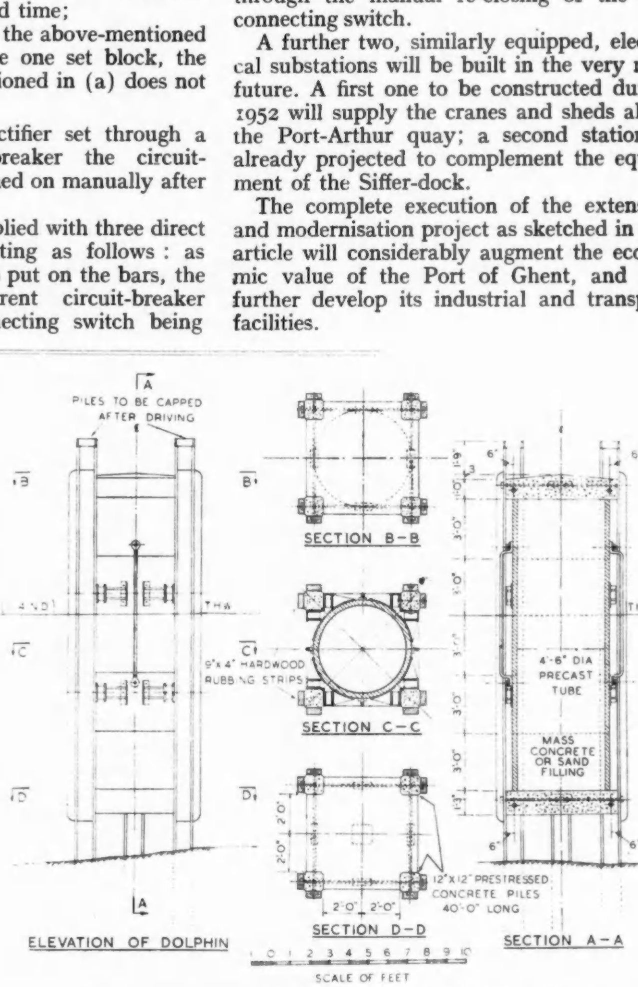
The central mass of kentledge is carried, partly on the fender piles themselves and partly on one load bearing pile driven on the centre line of the dolphin.

Impact forces sustained by one or two fenders are transmitted through the rubber buffers to the mass of kentledge which in turn receives additional direct and torsional support from the remaining fender piles, owing to the circular shape of the mass.

Hardwood rubbing strips are provided on all the contact faces of the fenders, and these may be either in close contact with the pre-stressed concrete piles, or held clear by intermittently spaced packing pieces, thus adding further to the initial absorptive power of the fender units. Owing to the circular shape of the central mass of kentledge, the rubbing strips can readily be removed and replaced.

The four-pile unit dolphin has been provided to cope with barge traffic, each barge having a maximum displacement of 350 tons. Other designs are under consideration for varying conditions, and any number of piles may be provided around the perimeter of the mass kentledge.

The rubber buffers have been supplied by the Andre Rubber Company, to a specified unit axial compression valve, and are bonded to mild steel plates for fixing to the dolphin, each buffer unit complete being readily detachable for inspection or repair.



FOUR PILE PRESTRESSED CONCRETE DOLPHIN

Additional mooring bars are also provided to avoid as far as possible, the fixing of hawsers around the actual concrete fender piles.

Details of the four pile unit are shown in the accompanying diagrams, which are self explanatory. It should be noted that the whole of the work can, in this particular case, be constructed above low water level.

Circumstances may arise, however, where the bottom platform and part of the kentledge would have to be constructed under water. In these cases, the lower platform may be pre-cast, whilst the shell of the central mass of kentledge, already being a pre-cast unit, could then be filled by means of a tremie.

A joint patent covering the above type of dolphin has been taken out by the North Thames Gas Board in conjunction with the designer.

Port Economics

Part 3. The Demand for Port Facilities

By A. H. J. Bown, O.B.E., F.C.I.S., M.Inst.T.
General Manager and Clerk, River Wear Commissioners, and General Manager, Sunderland Corporation Quay.

THE demand for port facilities comes immediately from shipowners, importers and exporters, but its expression through them is the result of economic influences radiating from primary producers, manufacturers, established markets, great centres of population and national governments. The simplest form of this demand is a ship seeking temporary shelter from bad weather: and the first development from this basic demand is a ship seeking a quay within a port in order that she may discharge cargo, or load it, or both. The man who made the first ship started the demand for port facilities: and the merchant—who, in former days, was often the shipowner too—backed him up.

For the most part, the early ships sailed out from the river ports of their own countries and sought the river ports of other, nearby lands. As their masters advanced in navigational skill, and as the shipbuilder's art developed, so the voyages grew longer and more venturesome. The first quays were the cobbled streets on the river-fronts of riparian townships. Such quays existed until recently in the heart of the city of Bristol and they are to be seen—and are in use to-day—at many old-established civic ports. The warehouses and counting-houses of the merchants and shipowners were hard by, and the bankers, brokers and insurance offices not far away. In essentials, the pattern is not greatly changed even in modern times—as for example in London where the City and warehouses meet and the river is close at hand.

Many ports began as harbours for coastwise shipping in the days when it was easier, safer and quicker to send goods round by the seaway and the estuaries rather than across country by the early primitive roads and tracks. Some of these ports have remained coastwise ports — or primarily so — to this day: others have developed into important ocean terminals.

The early vessels were small and therefore did not demand wide harbour entrances or deep approach channels: in the main, natural conditions sufficed. But because ships were small they were much at the mercy of wind and weather: and however small they were, they naturally preferred ports where there was always a reliable channel and some amount of water over the harbour bar. It is for these reasons that the earliest demand for port facilities by ships was for improved conditions at river entrances. The demand was met by beacons and lighthouses, the first piers and the first attempts at dredging. For example, the earliest artificial work at Sunderland, on the north-east coast of England, was a pier built in 1726 at the south side of the River Wear entrance with the object of controlling the river's flow in such a manner that a good channel might be scoured out and thus become well-defined and easy to follow.

In former times, many ships, entering river ports with cargo to discharge or take up, put down their anchors in the stream and did their unloading and loading by the assistance of small boats, lighters, barges or keels, using hoisting gear to convey packages to and from their holds and also opening their side-ports to receive or deliver additional cargo in cases or in bags or in bulk. The coal shipment trade on the north-east coast of England proceeded on this principle for at least 300 years and only changed with the coming of the railways round about 1830. Again, the traditional handling method at London is overside to or from craft: and, to this day, the lighterage business at London is of vast importance.

But ships grew in size and value, seaborne commence increased in volume and the lower reaches of trading rivers were constantly thronged with shipping. In consequence, ships demanded quays at which to lie and work with safety, expedition and economy, out of the way of vessels arriving and departing, and alongside the warehouses and the open storage areas. Also, an alongside berth was much more convenient for the ship's company and for all persons having business with the vessel during her stay in port. Thus it was that quays and landing stages came to line the banks of all commercial rivers. The ships demanded such accommodation and it was supplied: the question of who supplied it is dealt with later in this chapter.

In historical order, the next demand made by the shipowner was for conditions ensuring that his vessel remained always afloat instead of being left to take the ground at every period of low water. A ship is designed to float, and when she is not floating she is undergoing strain unless specially supported. Again, vessels taking the ground run the risk of bottom damage where the river bed is uneven, rocky or foul. There were other disadvantages connected with the old-fashioned quays in tidal water: frequently, the vessel sank so far below the edge of the quay that it became difficult or impossible to continue passing merchandise between ship and shore, and so work was constantly interrupted and time and money were lost: and, in case of fire breaking out on board or at an adjoining quay, a ship fast on the mud is a greater danger to herself and to surrounding property than a vessel afloat and movable.

In his book "The Ports of the United Kingdom," Sir David Owen remarks that the first mention of a wet dock on the Thames was about 1661 and relates to a dock at Blackwall adjoining a shipbuilding yard for the purpose only of fitting-out newly-launched hulls. Between 1696 and 1703, the Howland Great Wet Dock was built at Rotherhithe but this again was built for a harbourage and fitting-out place for ships and not for commercial purposes. Actually, the first commercial wet docks on the Thames were constructed for the West India Docks Company and were opened in 1802. Meantime, at Liverpool between 1709 and 1715, the Town Council had constructed the first commercial wet dock in England: they financed it by borrowing £14,000 under statutory authority and they were authorised to levy rates varying from 2d. to 1s. 6d. per ton on shipping using the dock. Shortly after 1737, a second dock was built and a third followed round about 1762. Thereafter, the great era of dock construction at Liverpool and throughout the Kingdom began.

The shipowners' demands developed further. By its very nature, an impounded water dock can only be entered or left by a vessel round about the period of high water, for it is only at this time that the dock gates can be opened without losing the impounded water and thus endangering vessels moored at dock berths. But this involves vessels wishing to leave, or wishing to enter, in much time lost in "waiting for the gates." The answer to this was a new sort of port facility—first the old-fashioned half-tide basin and later the modern entrance lock. The principle is well-known in our day and consists of the construction of a chamber between the tideway and the impounded area, with gates and sluices at either end, within which the level of water may be raised or lowered thus permitting a vessel to pass between the tidal water and the enclosed water even when their levels are different.

In regard to cargo-handling gear, most vessels carry some of their own in the form of booms, derricks, winches and deck cranes: but it is not always adequate and not always convenient for use at a particular quay. In consequence, as cargo quays were developed, shipowners began to expect to find them equipped with quay cranes of suitable capacity and variety and they are now very generally supplied by quay owners in most of the world's seaports. They are expensive articles—in initial cost, maintenance and operation—and, in consequence, it is a common practice among quay owners to require that ships shall use and pay hire for the quay cranes rather than use their own gear and let the cranes stand idle.

If a port can offer a vessel a safe approach from the sea and comfortable berthage alongside a well-appointed quay with sufficient water at all states of the tide, the basic demands of the ship

Port Economics—continued

have been met. Other needs of vessels, regularly supplied at seaports, have already been mentioned—and they include buoys, where necessary, to mark the approach channel, pilots, tugs, boatmen, mooring buoys, a stevedoring organisation, a labour force, drydocks and repair services, agency services, bunkers and bunkering berths, fresh water and stores. Lastly, special ships and special cargoes demand and must have special facilities—pipe-discharge systems for oil tankers, elevators for bulk grain, shipment staithes for the coal trade, grabbing gear for the discharge of bulk minerals and ores, elevators and travelling belts for delicate fruits and other goods, and swift-handling arrangements for frozen produce between ship and quayside cold store.

In the foregoing paragraphs we have considered the demands for port facilities which come from shipowners. What do import and export merchants ask for? Taking the importer first, it is his duty, in general terms, to accept his goods at the rail of the discharging vessel. Normally, it is not practicable for him to do so, and therefore he looks to the port organisation to have available some competent persons to receive the goods on his behalf and take care of them or deal with them in accordance with instructions which he has given or will give. That is to say, he requires the services of a master stevedore and a dock labour force and the use of a good quay, adequate cranage power and appropriate cargo handling gear. He has to settle his affairs with the shipowner who has brought his goods across the sea, and for this purpose he often appoints a local agent to handle the documents and see to the landing and forwarding. Most often, a ship can discharge cargo faster than the shore can take it and house it, and ship's time is precious: also, in addition to obtaining the release of his goods by the ship, the importer must also clear them with H.M. Customs. To meet all these requirements and to do the best possible for everybody—ship, importer and H.M. Customs—the transit shed was invented. It is a quayside building—with double-locks for H.M. Customs and the quay owner—which is regarded as a theoretical extension of the ship. Because of its special character, the ship can land goods to the transit shed as fast as the shore workers can take them: and the business of obtaining ship's releases and passing Customs entries can go steadily on as though the goods were still in the ship. The transit shed is therefore a port facility of great advantage to the importer and also to the shipowner. Moreover, whilst the goods are being received into the transit shed or passing through it or lying in it, they can be identified, tallied, sorted, sampled, tested, weighed, measured, opened for inspection, examined by H.M. Customs, re-coopered, labelled or sub-divided into smaller lots as may be required. All such demands as these are made by importers and are in the nature of port facilities, regularly supplied.

The importer may desire to store his goods, in whole or in part, at the port of reception: or he may desire that some or all of them be sent away from the port by rail, by road, by lighter, by canal craft, or by coastwise vessel. If it is storage at the port that is required, the importer will be wanting space in a cargo warehouse, a granary, a cold store, a bonded warehouse, oil tankage, a timber shed, a timber pond or on open stacking ground. He may be a dock tenant and have the necessary accommodation in his own right, or he may have to look to the port authority or a warehouse-keeper to house his goods. In any case, the goods have to be transported from the berth to the place of storage and this operation will be accomplished by railway, by road vehicle, by roller runway, by overhead carrier, by travelling crane, by electric or petrol-driven wagons, or by fork-lift trucks.

It may be useful, at this stage, to remark that the term "port facilities" is employed above in its broad and modern application. For many years, it was fashionable to make a sharp distinction between port facilities, on the one hand, and port services on the other—the expression "facilities" being entirely reserved for those of a static nature whilst "services" related exclusively to operations performed. For example, a quay was a port facility but unloading a ship was a service. There is a good deal to be said for these distinctions and further reference will be made to the matter. In the present context, however, port facilities means anything and everything that port users may hope or expect to find in such places. It is noteworthy that the expression "port facilities" is defined very broadly indeed in the Transport Act, 1947, and certainly includes many things which used to be called "services."

If the importer wants goods sent away by rail he will hope that the discharging berth is rail-connected and that there is a railway organisation of some kind in being. He will expect that some dock labour employer will be available and willing to put on work-people to load the goods into the wagons or vans. He will expect corresponding facilities to be available for loading and despatch by road transport. Where there is need or opportunity to use the water-route for oncarrying work, he will expect the port organisation to include facilities suitable for the reception, berthing and working of barges, lighters, canal craft and coastwise ships. He will expect that those to whom he has entrusted the care of his goods—whether it be port authority, dock authority, quay owner, forwarding agent, master stevedore, master porter, or warehouse keeper—to keep him advised when goods are depatched and to give him a statement showing him precisely what goods were landed by the ship for his account and how the outturn compared with the bill of lading. For all these services he will expect to pay the tariff charges or proper charges as may be agreed, including periodical rent accounts for goods remaining in warehouse or in open storage.

Broadly speaking, the exporter requires the same port facilities in reverse: and the special port facilities required at passenger ports have been referred to earlier. Detailed descriptions of many types of port facilities, their layout and their operation, will be found in "Port Administration and Operation" (Bown and Dove—Chapman and Hall).

We have now examined the demands for port facilities made by shipowners, importers, exporters and passengers and we must shortly consider how and by whom these wants have come to be supplied. Before turning to supply, however, it will be useful to look back behind the shipowners and the merchants and try to form ideas as to the influences which set them going and kept them going so that, as a result, they came to demand port facilities all over the world and are continuing to demand them in our day. The first answer is that both the shipowner and the merchant hope to make some money for themselves by providing valuable services for which the community will be willing to pay. The merchant is willing to buy wool in Australia to sell in London for manufacture in Yorkshire in the belief that when he has paid and been paid, there will be something left over to reward him for his knowledge, judgment and zeal and to recompense him for the risk of his capital and for its use in trade. The shipowner is willing to pay heavily for a ship and to keep her officered, manned and maintained, in the belief that there will be merchants in London wanting Australian wool, and others like them, and that some persons will be willing and able to pay him sufficient money for the sea-carriage of their goods to enable him to pay his own way and have something left over for himself. In other words, if overseas trade and the owning of ships ceased to be profitable enterprises something would probably happen to the demand for port facilities.

But, in 1952, it is not enough to leave the matter there. The present generation has lived through two devastating world wars, and, for good or evil, has seen Governments conducting international trade on their own account, has watched the uprise of nationally-owned merchant fleets, has been introduced to the totalitarian state and has become accustomed to a large measure of Government participation and control over the whole field of world commerce. It is evident, therefore, that certainly under wartime, between-war and post-war conditions—if not under all conditions—there are forces which operate to keep world trade moving even when the merchant and the shipowner cease, for the time being, to be independent and free private enterprisers. We can point to some of these forces—and their importance, in the present study, is that they tend to show that the demand for port facilities is, to a substantial extent, a steady and permanent feature in world affairs.

The strongest of these underlying forces springs from a pair of complementary facts—namely, in some parts of the world, human beings have become so thick on the ground that their own countries do not produce enough food to keep them alive: whereas, in other

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parts of the world, the population is scanty but food-production is enormous. The over-populated regions will clearly always seek to import food from the agrarian lands, the latter will be willing to send it in exchange for commodities which they themselves need, shipowners will thus be provided with cargoes and port facilities will be required in all the countries concerned. The uneven distribution of population over the world's surface combined with its uneven fertility is the mainspring of overseas trade and is therefore a primary cause of the demand for port facilities. And behind the distribution of population and of food-producing power lie other factors. Among these we may note differences in climate which in turn account not only for differences in fertility but also for differences between races in the matters of energy and industry and for concentrations of population in certain areas and not in others. Another underlying stimulant of seaborne commerce (and therefore of the provision of port facilities) was the oncoming of the machine age and the consequent demand for power-driven appliances and services which sent men searching the world for supplies of coal, iron ore and petroleum. None of these minerals are evenly spread but, in 1952, every country in the world wants one or more of them in large, regular quantities. Even in the remotest agrarian areas, the plough-oxen are rapidly giving place to the power-driven tractor—indeed, were it not so, the large-scale farming of our day would not be possible. The carriage of the power-yielding minerals means more work for the ships and the resultant increased production of food means more again. Once more, it used to be said that trade follows the flag, and it is manifest that the colonising activities of the British, French, Dutch, Belgians and Germans have done much to add to the volume of seaborne trade. Yet again, the spread of western civilisation amongst the uncounted millions of Asia and Africa has set up a demand—not yet nearly supplied—for the material comforts and appliances which are the outward marks of urban life in Europe and America. The main lines of world trade may not be so straightforward as they were when Queen Victoria was a young girl: and although Britain has long ceased to be the world's only workshop it is still an important one amongst a number of others: and there are still great areas across the seas where the principal means of life will continue to be the extraction of mineral wealth, the cultivation of the soil, the raising of animals for food, and the exportation of the surpluses in exchange for manufactured articles.

So much then for the demand for port facilities and for the factors which give rise to such demand. It is now appropriate to consider how and by whom the demand is met.

The first thing to note is that when ships were small their wants were comparatively few and simple — a peaceful haven formed nearly the sum total: the early ports developed in places where natural quiet anchorage already existed: and the trader, for his part, frequently possessed or built his own warehouse on or near a river wharf which he had himself provided. In places where trade expanded, or appeared likely to do so, the leading merchants and shipowners sometimes joined together to build quays for their common use: and where the prosperity of the whole town depended largely upon the coming and going of ships and the trade they made, the construction of quays, the care of the river and the improvement of the port were often undertaken by the whole body of citizens as a civic duty at the public expense. If the port was popular and convenient and if the place became an established market, the citizens were able to recoup themselves by levying a duty on ships and merchandise using their quays. These early principles are much alive to-day and can be found as active elements in the organisation of many of the world's seaports.

The supply of port facilities, and certainly their adequate maintenance, is a task which has always involved expense for somebody: and, therefore, throughout economic history, it is constantly met with as a duty laid upon some person or persons simultaneously with a grant of rights. The course of the matter was pretty common everywhere. The original natural facilities of harbour and river became inadequate, neglected, decrepit, overcrowded or inconvenient. Traders and shipowners began to dispute among themselves and the intermingling of races, characteristic of seaports, made for more bad blood and cried out for regulation and control. What was everybody's business became as usual, nobody's business; trade stagnated, river thieves flourished and the community suffered accordingly. It was in circumstances of this sort that the King, or the lord of the manor, or the bishop of the place was often petitioned by a public-spirited man or a group of traders or the leading citizens: and the result—examples of which are to be found in the history of many seaports—was the grant of a charter or letters patent, making regulations for the port and its trade, placing upon the grantees the duty of carrying out improvements and giving them the right to exact payments from shipowners and traders for the privilege of using the port facilities.

The formation of private or public companies for the purposes of port improvement and administration was a natural development from all that went before. As ships grew larger, dredging became an expensive duty and the essential equipment for the task was costly to purchase, to operate and to maintain. At many places, schemes for protecting piers and breakwaters were shown to be necessary and very large sums of money had to be found. Above all, the invention of enclosed docks led to a widespread demand for such accommodation and it also opened up the opportunity of creating a port where natural facilities were meagre or even non-existent. Such companies, especially when looking to the general public for financial backing, had to succeed if they were to survive. Some of them flourished exceedingly: others failed: yet others gave way, in course of time, to other forms of control.

The canal era came and, in their heyday, the canal companies sometimes laid out their own terminal facilities or added improvements to existing ports. After the canals, the railway age dawned and, in due time, the railway companies began to build their own docks, frequently at existing ports. About one-third of the total port and dock facilities existing to-day in Great Britain were supplied by the subscriptions of railway shareholders. Their view was that the docks would feed the railways and the railways would feed the docks. Often, the necessity of dock construction was forced upon the railway companies, as in the case of South Wales. The wonderful new boon of the iron way took the mineral wealth of every Welsh valley down to the sea but this was useless without adequate means of shipment and good berthage for the ships.

And so the new railway-owned docks developed in various countries alongside privately-owned wharves, municipal quays, docks built and operated by public companies and sometimes by private persons, and in ports where not infrequently a statutory body of conservators or port trustees or port commissioners already existed. On the Continent of Europe, there developed a fairly common arrangement whereby the national state built the port up to quay level and the municipality constructed everything required above that level. In Great Britain, government intervention in port organisation was practically unknown prior to the Transport Act, 1947.

Varying interests, existing side by side in the same port, each of them controlling some section of the port facilities, did not always tend to the welfare of the trading community or of the public at large. Fierce competition, overlapping, wasteful expenditure and even internecine strife were not unknown: and, therefore, in not a few cases, a solution was sought and found by Parliamentary action resulting in the placing of most of the administration in the hands of one public body—usually a statutory public trust, either already existing in the port, or, if not, specially created. The Port of London Authority, the Mersey Docks and Harbour Board and the Clyde Navigation Trust are three of the most important from among the many port trusts thus brought into being in Great Britain. At Bristol, when opposing interests threatened to block progress, a solution was found by legislative action which resulted in the municipality taking control of the whole port and outlying docks, with great benefit to all concerned. At Sunderland, the Comissioners of the River Wear having carried out conservancy duties for many years, found themselves at a later date with a railway-owned dock and a company-owned dock within their confines: difficulties developed and, as a result, the Commissioners were re-constituted as the supreme authority for port and docks.

In addition to the foregoing, port facilities are sometimes created or are extensively improved, through the action of national governments, of local or district governments, of public or private

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companies formed to exploit the mineral resources of a particular country or district, or of agrarian communities requiring more or better shipping opportunities for their produce. One of the early reasons for the development of London as a port was its close proximity to the most fertile part of Britain: Abadan became a seaport of world importance because oil was struck a hundred miles away in the south-western hill ranges of Persia: Seaham Harbour, on the north-east coast of England, was made into a useful port because the adjacent group of Londonderry collieries sought a cheap outlet to the sea. Manchester is an astonishing example of a resolute mercantile community determined to make their inland city into a first-class seaport: and so a company was formed to prolong the Mersey by building the Manchester Ship Canal and the commodious Manchester docks: and when the burden of this colossal task appeared likely to defeat the Company, the civic authority of Manchester stepped in and saw the job through.

National governments sometimes interest themselves closely in the provision or acquisition of port facilities Before the Second World War, Poland undertook great developments at its port of Gdynia: after the close of the war, the Soviet Union demanded and acquired from Finland the port of Viborg (re-named Makslahti) in order to have a window on the Baltic: and, in 1951, a British Government scheme for huge developments at the port of Mtwara in East Africa—in order to take care of the projected ground-nut export—was halted because the original project had been heavily scaled down but may yet be revived to provide an outlet for new coal production in Northern Rhodesia and as an alternative to the overcrowded ports of Dar-es-Salaam and Beira.

The flow of seaborne commerce is seldom entirely steady for long, in volume or in direction, and, in consequence, port operators are constantly being faced with either a feast or a famine. The vagaries of wind and weather have much to do with this: but other underlying causes are the occasional failure of important crops; the gradual exhaustion of some mineral deposits and the development of others: the icing up of certain ports in winter months: international tensions or military campaigns inducing the diversion of traffic and tonnage; labour disputes in port areas or in their industrial hinterlands; the shortage of ships in some trades owing to other trades offering better freight-earning prospects; the incidence of seed-time and harvest the world over; the gradual neglect and silting up of certain old ports because their staple trades have died, or modern inland communications have bypassed them; the growth in the size of ships; the competition of other ports, more modern and convenient, giving better despatch and possibly cheaper to use; currency control, import duties, tariff quotas, Government bulk buying and the action of Governments in encouraging all exports, or some exports and not others, or in restricting, wholly or partially, the inflow of imports.

Because the demand for port facilities at a given place is variable, port administrators do not attempt to cover all possible traffic peaks when planning, laying out or improving their facilities. To do so, would be to reduce millions of pounds of capital to wasteful sterility as well as to increase, unprofitably, the annual charges for maintenance and operation. The normal approach to this problem is to plan facilities adequate in capacity and variety to take care of a good average volume of business: and then to go just so far beyond this line as prudence, backing, enterprise, foresight and belief in the future appear to justify. Such decisions play an important part in port administration.

It may be useful to add a few examples in illustration of some of the foregoing general propositions:—

The erratic flow of trade. Example:—

As an actual instance, taken at random from the records of a port on the north-east coast of England where there are six general cargo berths, the following details show the demand for cargo working facilities over a period of twelve days in July/August, 1950 :—

31st July	...	3 vessels working.	
1st August	..	1 ,, ,,	
2nd ,,	...	2 ,, ,,	
3rd ,,	...	3 ,, ,,	
4th ,,	...	3 ,, ,,	
5th August	...	3 vessels working.	
6th ,,		(Sunday).	
7th ,,		(Bank Holiday).	
8th ,,	...	6 vessels working.	
9th ,,	...	6 ,, ,,	(and 3 awaiting berths).
10th ,,	...	6 ,, ,,	(and 2 awaiting berths).
11th ,,	...	5 ,, ,,	

Mineral deposits and port facilities. Example :

The main business of the town of Middlesbrough, on the north-east coast of England, is the production of iron and steel. The industry took root there because of the local availability of coal and of the Cleveland Main Seam of iron ore. As the business grew, the furnaces became hungry for greater quantities and differing qualities of ores. These had to be imported and, in consequence, facilities for the reception of iron ore carriers and for the discharge of their cargoes were provided and have since been continuously developed at this port.

Icing. Example :

Owing to the winter freezing of the St. Lawrence, the season of navigation at the port of Montreal, Quebec, Canada, is restricted to the period extending from the 15th April to the 30th November. It follows, therefore, that during the annual ice season the demand for port facilities is transferred from Montreal to the nearest ice-free ports such as Saint John, New Brunswick.

International tensions and military campaigns. Examples :

In the present year, 1952, one of the features of the international scene is ideological incompatibility between Communist countries on the one hand, and the non-Communist nations on the other: and some common ground, upon which the future harmony of the world may be established, is being earnestly sought but is not yet found. In these circumstances, the non-Communist nations have begun to rebuild their defensive armaments so that their peoples may not be left helpless if war should come again. This situation, following upon the wreckage and devastation of two world-wide conflicts within the space of twenty-five years, has profoundly affected the flow of world commerce and therefore the demand for port facilities in many places. At the time of writing, China has been torn and impoverished by years of internal strife: Korea is at present a theatre of civil war: Japan is a defeated nation and under American occupation: unrest and violence are upsetting normal econom : life down through the Malay peninsular: the India of former times is now split and uneasy: Persia, Israel and Egypt are going through political and economic changes: Russia maintains an outward and official attitude of aloofness towards non-Communist countries: America has abandoned her belief in isolation and is active everywhere in the resolute pursuit of democratic preparedness: and Germany and Italy are rebuilding their economic structures, their trade and their ports after suffering crushing defeat in war. The present state of international seaborne commerce reflects these political influences: the rich trades of the Far East mean less than they did in the world's markets: the re-arming countries are clamouring and competing for iron ore and scrap metal—one result being a dearth of scrap inwards at British ports because of a marked diversion from the Continent to ports of the U.S.A.: British coal is wanted almost entirely for home needs with the result that the export trade is heavily scaled down: another result is that Britain has been importing coal from America and this, in turn, has diverted tonnage away from the carriage of iron ore and thus aggravated the position as regards the U.K. import of foreign ore: and the Korean war is demanding the services of many ships thus causing a shortage of tonnage which has been felt in various directions, including the import trade in softwoods and pitwood from the Baltic to U.K. ports. All these influences, and a score of others, result in variations in the demand for port facilities in different parts of the world.

Labour disputes. Example :

The prolonged and widespread troubles which marked the year 1926 in the United Kingdom fell with especial severity upon the coal export business and, in the opinion of many, did it permanent injury. Certain it is that some foreign customers were lost and

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were never regained and the demand for port facilities at the coal export centres was thus weakened and has so remained. Disputes and unofficial strikes amongst general cargo workers at London, Liverpool, Bristol and Manchester have broken out occasionally in recent years and the immediate result has been a temporary drop in the supply of port facilities in the ports affected.

Incidence of harvests

An important section of the world's seaborne trade consists in the carriage of grain, in bulk or in bags. Owing, however, to the very general practice of storing grain in silos and loft warehouses, chiefly at the seaports, and shipping it in accordance with market conditions and world demand, the pressure upon discharging facilities at reception ports remains fairly constant and does not commonly rise noticeably at harvest periods. With fresh fruits and fresh vegetables, however, the position is different: and definite shipping seasons occur which, in turn, give rise to seasonal pressure upon the port facilities at the loading and at the discharging ports. Again, however, it should be noted that this feature is more or less confined to the short sea trades: thousands of tons of fruit are regularly carried longer distances, pretty well all the year through, because of developments in refrigeration, chilling, special packs, ventilated holds and special fruit storage rooms at the ports. The same remarks apply to spring lamb and eggs which, by nature, belong to a particular part of the year but which, by man's ingenuity, are nowadays preserved, stored and shipped throughout the year.

The decline of ancient ports.

There are a number of ports which were once of great eminence but are of less importance in modern times. In his "Ports of the United Kingdom," Sir David Owen refers to Tewkesbury on the Severn, Oxford on the Thames, Ware on the Lea, Lincoln on the Witham, York on the Ouse, Hereford on the Wye, Chester on the Dee, Caerleon on the Usk, Norwich and Bawtry, Lympne and Richborough. The last two of these, with Dover, took care of shipping between Britain and the Low Countries before the uprise of London: and the others were notable river ports, often a long way from the coast, and therefore less open to surprise attack by an enemy approaching by sea. When England was a pastoral, agricultural, sheep-rearing country with an economy based on the land and local handicrafts, the old river ports were in the right places: but when coal, iron, machinery, and the factories became of primary national importance, the case was altered: manufacturing centres arose near the mineral deposits and big-ship services were required, as near as possible, for the import of raw materials and the export of finished goods, semi-finished goods and coal cargoes. The coal owners, the iron smelters, the manufacturers and the railway builders may be said to have made the modern ports of Glasgow, Belfast, Liverpool, the South Wales ports, Southampton, Hull, Middlesbrough, Sunderland, Newcastle and Blyth. Where such influences did not exert a direct effect, the ports of former times tended to decline and this is what happened to the famous townships mentioned earlier. There are, however, three outstanding exceptions to this fairly general rule—namely, London itself, Bristol and Edinburgh (with Leith). These three are great ports not so much because of coal, iron, industry and railways but because each is situate on a fine estuary, each early became a great centre of population and wealth, and each has been blessed for generations by citizens well accustomed to business enterprise, and possessing a knowledge of markets and finance, skill in the ownership and management of ships and an unquenchable spirit of merchant adventuring.

The growth in the size of ships

The increasing size of ships in modern times has profoundly affected the demand for port facilities. In cases where the governing body of the port has been unable or unwilling to enlarge the facilities, the port has fallen in status from an ocean terminal to a coastwise port or a fishing haven, and the ocean trade has gone elsewhere. But in places controlled by far-sighted and courageous men, vast sums have been spent either in modernising the old facilities or in building new ocean docks, usually at a position nearer the river mouth than the site of the original quays. Examples of this process are very numerous in the United Kingdom—indeed it is true, in greater or less degree, of practically every British port flourishing to-day.

A few figures, from one port, relating to ship sizes and port accommodation, may be useful in illustration. At Sunderland, on the north-east coast of England, in the year 1868, the number of vessels cleared in the foreign trade was 2955 representing 731,413 net register tons—that is, an average per vessel of 247 net tons. The corresponding figures for the year 1950 were 533 vessels representing 550,475 net register tons—that is an average of 1033 net tons: and the total included 20 vessels each over 5,000 tons net. The largest dry dock in the port until 1925 was 441-ft. in length. In that year a 500-ft. dock was built. In the present year, 1952, a dock measuring 675-ft. is in course of construction: it is designed to take tankers with a capacity of 32,000 tons. Recent new ship launches at Sunderland have included vessels with a capacity of 23,000 tons.

Looking at the whole world merchant fleet there are now about 60 vessels afloat in the class above 20,000 gross tons ranging up to the Cunard-White Star liner "Queen Elizabeth" at 83,673 gross tons. It would not appear that the ultimate limit has yet been reached in the size of ships and as previously mentioned, the whole question is of vast importance to all concerned with the demand for port facilities.

Elasticity of Demand.

Finally, in discussing the demand for port facilities it is appropriate to consider the economist's notion of elasticity. So far, in this chapter an attempt has been made to show how the demand has arisen and has been met. The approach has been of a descriptive or historical nature. But the current scene must not be ignored, and it is in this connection that the elasticity of demand for port facilities may be mentioned.

The economist must assume that those in charge of a port want to maximise their profits. He will argue, therefore, that an awareness on their part of the elasticity or inelasticity of demand for various facilities is of significance for the attainment of this end. To put it quite simply, the elasticity of demand for port facilities is the rate at which the demand changes as port rates and charges are varied.

Following an increase in charges, the trade of a port may either remain the same or it may decrease. If it is the only convenient port for a hundred miles, or if it has special facilities to offer, it may be able to increase its charges very considerably without losing much of its trade. On the other hand, a port may find that a decrease in its charges produces negligible results on its volume of trade. In either case, the demand for facilities is said to be inelastic; a change in charges leads to a less than proportionate change in demand.

In the opposite case, however, competitor ports, offering similar facilities, will tend to cause a more than proportionate change in demand following a change in charges by one of them. An increased charge in such a position will lead to a considerable loss of trade to the other ports, and a decrease will succeed in attracting a fair amount of custom away from other ports. Demand, in such cases, is said to be elastic.

Clearly, this notion of elasticity is of some importance in port economics. In simple practice, for example, it may only mean that it pays a port authority to be aware of its unique provision of a particular service or facility, and to realise its ability to charge adequately for it in the absence of substitutes. But the juggling of charges implied by the theoretical proposition is somewhat invalidated in practice by the many other factors outlined in the foregoing paragraphs.

Advertising and Publicity.

A port undertaking, however it may be governed, has special and peculiar characteristics as a commercial enterprise. It is partly a public utility and partly an industrial organisation. When the port is owned by the nation, the state or the city—as in some cases—it is able, in the last resort, to rely upon the taxpayer or the ratepayer: though even so, it is obviously desirable that it should establish, for itself and on it own account, a sound financial basis with all possible speed. When the port is owned by an individual

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or a company, it is on all fours, as regards finance, with a privately-owned factory—except that its charging powers are normally limited by Government control. But when—as is so often the case—the well-being of a port undertaking rests in the hands of a non-profit-earning public trust—that long-tried and generally successful type of port government—the trustees often find that they must try to make the best they can of the worst of two worlds. On the one hand, they are always conscious of their duty as the providers of an essential public utility, comparable, in many respects, with, say, the main highways of their country: but, on the other hand, they must obtain their revenue, not by a rate imposed by authority upon the citizens at large, but by successful trading. It is for this reason that port and dock authorities must consider the advantages of advertising and publicity. The great, historic seaports of the world, with their multitudinous established steamship services (frequently having permanent shore bases within the port confines), need do little more than show their illustrious names from time to time by using the most suitable media and observing a proper dignity in the manner and matter of their public announcements. Nevertheless, in our day, they frequently do more: for, however eminent and international a port undertaking may be, there is always a body of information—some of which changes annually or from time to time—which needs to be communicated to shipowners, traders, industrialists, travellers and the public at large. Such desirable announcements include tide tables, harbour and dock bye-laws, tables of dues and charges, details of vacant sites, information relative to harbour lights and signals, details of consular and other services and particulars of new facilities or of facilities temporarily suspended or entirely discontinued or replaced. Yet again, the efficient management of the world's seaports, and the essential part they play in world trade, are subjects of importance to teachers, students, economists, geographers and to a vast host of thoughtful people the world over: and it is with them in mind, as well as for other reasons, that port and dock authorities spend money upon the production and distribution of handbooks, guides, diaries, brochures, films, advertisements in newspapers and periodicals, models for display at exhibitions, and the like.

It must be remembered, too, that as world transport has developed and speeded up, and as the remotest regions of the earth have been brought by the advance of science more and more into actual or potential productivity, so have the old lines and foci of world trade become more susceptible to challenge—a challenge, moreover, which has been accentuated by the devastation of war, the clash of political ideologies and general economic upheaval. In such circumstances, the seaports of every trading country must speak, in a very real sense, for the country itself. It is well, therefore, that the widest and best devised publicity should be given by the port authorities of the world to what they have to offer to shipowners and traders in every land, who, pursuing their lawful occasions, seek an honest profit by promoting the transport and the exchange of the earth's yield and the varied products of industry.

Two questions arise. How far should a port authority go in the matter of advertising and publicity? And to what extent, if at all, is it desirable that port undertakings should compete for traffic?

The answer to the first question is one that every port authority soon solves for itself. The proportion of revenue devoted to such purposes is normally very modest and, happily, the desired object is capable of achievement at a small outlay. Even when the cost of a commercial department and canvassing staff is added to the forms of publicity mentioned above, the total expenditure in most cases, is probably far less than one per cent. of the gross revenue.

In regard to the second question, the answer must be (1) that competition is an inescapable element if shipowners and traders are to have any freedom of choice, (2) that seaports conduct an international business, and (3) it is impossible—without an all-powerful world government—to conduct international business without allowing freedom of choice. The scope for competition is not large—and within that scope it can be kept healthy and stimulating. The scope is necessarily restricted because a port undertaking can quickly reach disaster by lowering its charges to uneconomic levels or by overspending on capital account. The financial boundaries of competition are therefore inexorably set: and, within them, competition expresses itself normally and naturally by vigorous canvassing, keeping charges as low as possible, efficient operation and sound administration, speed in traffic handling, well-conceived publicity and the continuous improvement of port facilities at the fastest rate which the economy of the undertaking will prudently admit.

Utility and Value in Relation to Ports.

For the student in particular, it will be useful now to consider the economic concepts of value and utility in relation to ports. Value means value in exchange: and price is value in terms of money. Utility may be briefly defined as value in use. It relates to the underlying law by which a man spends his income—and, more particularly, the last pound of his (expendable) income. There are two points of view here and it is important to consider both. There is the viewpoint of those who control the port facilities and offer them for use: and there is the viewpoint of shipowners, traders and others who may or may not avail themselves of the opportunities thus offered to the mercantile community.

The strictly correct chronological order is the reverse of that stated above—for until the shipowner and trader choose to spend some of their money in a particular port, the port authority can have no true revenue of its own to spend. But, in practice, the port authority borrows money from the general public or invests money of its own in laying out a port or improving it, in the belief that ships and cargoes will come to them and will pay sufficient in dues and charges to enable the port undertakers to pay interest on the borrowed money (and eventually to pay it off) as well as to administer, operate and maintain the port facilities.

If we consider the case of a shipowner with a fleet in being, the concept of value in relation to ports applies to him on the following lines. He is normally loading his ships at certain ports. He loads them as full as he can and with the best-paying cargo he can obtain—always taking the long view of trading connections as well as considering the short. He is normally discharging his ships at certain ports across the seas: and he has been telling the world, for some years, that his ships maintain this particular service. When he instituted this service, and when he is considering expanding it, or reducing it, or giving it up, one of the several factors in his calculations must have been, and must continue to be, the number of pounds or dollars he must give in exchange for the facilities provided for him at each loading port and at each discharging port. There are many other factors—and, it is safe to say that in times of stress, the most important of all is the availability of cargo which is the life-blood of his business. But, generally speaking, the shipowner must, from time to time, weigh the value and utility to him of the facilities available at the ports he is using and he is entitled to compare them with what he might conceivably obtain elsewhere. Other things being equal (but they almost never are) he will obviously load and discharge his vessels at the cheapest ports at which he can berth them. But against this he must consider the demands of shippers as to ports of loading, the demands of receivers as to ports of discharge, the maximum amount of time he may dare spend loitering along coasts, and all the other considerations which have been outlined earlier in connection with the hinterland theory. In other words he may conceivably save x pounds in port charges by substituting port A for port B but lose 200 x pounds in the process.

From the point of view of the importers and exporters, the most desirable ports are those which will involve them in the lowest dues, handling charges and on-carriage costs. They will exert all the pressure they can to persuade ships to come to the ports of their choice and the merchant, or group of merchants, with the heaviest, most lurcative and most regular shipments to offer will win the argument and the remaining shippers will be placed at a corresponding disadvantage.

Value and utility, in the mind of a port authority, are considerations which affect decisions that must be made in regard to their spending programme. If they are proposing to borrow capital to spend upon improvements, they will have interest and sinking fund charges to provide out of revenue and they must therefore consider which particular improvements, out of all the things which might be done, are the most likely to bring enough revenue to pay for themselves. In times of good trade in a port where much modernisation is needed, the list of desirable works is likely to be a long

(concluded at foot of page 347)

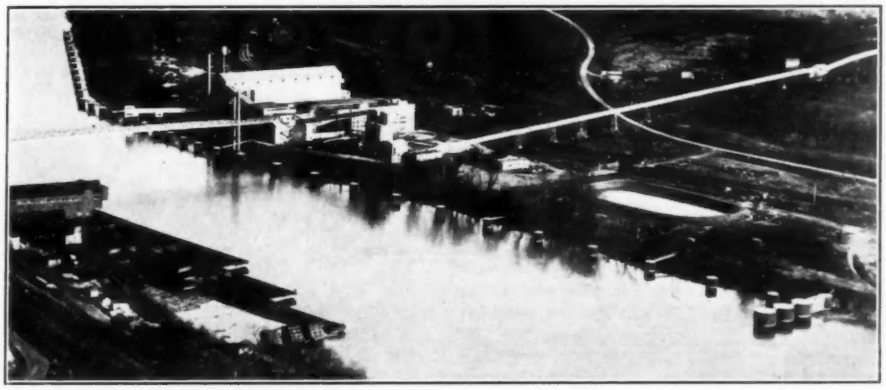
Cellular Dock Construction in the United States

By F. J. LARKIN
Engineer, Contracting Division, Dravo Corporation.

To-day, in the United States of America, the increase in current defence production has brought about a greater utilisation than ever before of the inland waterway system. Bulk commodities such as coal, coke, petroleum products, finished steel products and many others are moving from mine to mill or from mill to market by barge. A number of new industries are locating along the waterways to take advantage of this transportation medium, and many older plants are expanding their river shipping facilities for a similar reason. To facilitate the provision of the new or expanded facilities it is necessary to provide additional dockage, and the biggest part of this problem is how to get the increased dock capacity into operation in the shortest possible time.

The answer has been found in steel sheet pile docks of cellular construction, one of the most rapid and economical methods in use to-day. More of these projects than ever before are now underway in the Ohio Valley, where this construction method was pioneered over 20 years ago. Dravo Corporation's Contracting Division has been especially active in this field for many years, and in the past several years alone, over 30 installations have been made in this area for power plants, mines, railroads and steel mills, and the outlook is for general extension over the inland waterway system.

Typical of the structures mounted on river docks is this 500-ton-per-hour capacity coal unloader for a public utility power station. The foundation consists of a concrete-capped steel sheet pile cell 38-ft. 2-in. in diameter. The mooring facilities included 7 cellular steel sheet pile cells, 2 ice breaker cells and a spur dike.



Covering a 3/4-mile stretch along the Monongahela River near Brownsville, Pa., this dock improvement project included the construction of 39 steel sheet pile cells, four of which comprise an ice breaker.

Docks of this type consist of a row of steel sheet pile cells, spaced on convenient centres, along which barges are moored and moved. At the upstream end are cellular ice breaker piers to protect the harbour from ice, drift and current. Usually in the centre of the dock is a large pier of similar construction on which is mounted loading or unloading machinery — a crane, an ore bridge, a straight-line coal unloader, a pipe line, or a conveyor belt. Suitable barge haulage and mooring apparatus complete the installation.

Works of this nature can be completed months ahead of similar construction carried out in concrete—and with a permanence very nearly on a par with concrete. The advantages are numerous. There are no cofferdams to build to keep out the river. There are no foundations to prepare. Form work is limited to what concrete structures the owner may desire on top of the dock. The concrete work is confined to the small amounts needed for capping the cells. The cells are filled with sand and gravel usually dug in the vicinity. Almost any heavy pervious material of a durable nature, not injurious to steel and capable of mobilising shear value, will serve for fill. Such fittings as mooring rings, access ladders, and check posts are bolted or welded to the steel piling when it is placed. In short, the dock starts to grow rapidly from the start.

Other advantages besides speed of construction are found in the flexibility of such a dock. The numerous possibilities of cell arrangement permit almost any sort of harbour layout. For future needs, extensions are easily made by adding as many cells as may be necessary. In later years, should portions of the dock have to be relocated, the cells are easily dismantled by removing the concrete deck, digging out the fill, and extracting the piling. Salvage is almost 100 per cent, apart from the concrete deck.

The cells are designed to a convenient height — usually above flood water — and of a diameter and penetration sufficient to make them stable against overturning. The site of each pier is pre-dredged to good material, and the piling set around a template anchored at the site. After piling is set and driven, mooring rings and built-in ladders are installed before filling the cell. Grading the fill and concreting the deck completes the structure.

The first use of a steel pile cylinder for mooring purposes on the Ohio River was at Dravo Corporation's Neville Island Shipyard near Pittsburgh in 1930, and this cell is still in service today.

This type of dock is not confined to inland waters. Tidal estuaries, bays and harbours suitable for ocean-going vessels can be equipped with steel sheet pile docks. Due consideration must be given in the design for the greater mass of the individual units handled at the dock and for greater depths of water. Graving docks capable of handling the largest combat vessels afloat have been built of cellular construction, further demonstrating the versatility of steel sheet piling. (See "Submerged Shipways with Steel Sheet Piling Walls," by C. B. Jansen and A. J. Ackerman, in "Civil Engineering," U.S.A., July, 1943.)

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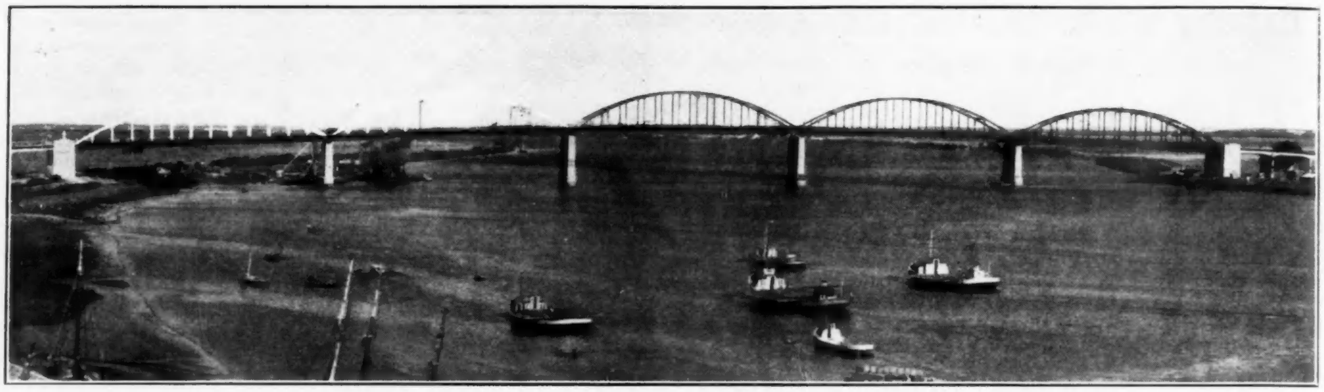
one and, although much may be embarked upon, there will always be some proposed works deferred for consideration at an undefined future date. The point where the line is drawn marks the limit of utility at that particular time. Many subsidiary matters, associated with utility, arise when a port authority is planning ahead. After a period of lean years, it is sometimes necessary to spend money not in the hope of increased revenue but simply to preserve existing sources of income. Again, when two or three different sections of traders are demanding new or better types of equipment — each different, each good in itself, but none very likely to pay for itself—it is sometimes good policy to spend any available resources upon plant of a general utility nature which is at least likely to confer some benefit upon a good number of the users of the port. And yet again, it is always desirable, in assessing potential utility, not to stop the consideration at the proposed new work itself and its immediate purpose but to look beyond it, so far as possible, at other advantages or additional business that might conceivably accrue as the result of its execution or acquisition.



View of completed Vila Franca de Xira Bridge.

New Bridge over River Tagus

Five Spans of Tied Arches

One of the most important improvements in road communications on the Continent has been effected by the completion of the new bridge over the river Tagus at Vila Franca de Xira twenty kilometres up stream from Lisbon. The need for better communications across the Tagus has been long recognised as necessary to facilitate contact between Lisbon and the South and East of Portugal. Before the building of the Vila Franca bridge there was no bridge below Santarem, eighty kilometres up stream from Lisbon. Various schemes for bridging the Tagus near Lisbon have been frequently considered but were abandoned because of the width of the river and the difficult foundation conditions in the vicinity of the capital.

Vila Franca de Xira is the first point at which the river narrows sufficiently and the foundation conditions are favourable enough to render construction of the bridge reasonably economical. In 1947 the Portuguese Government issued invitations to tender for the construction of a highway bridge at this point where a ferry is at present operated.

The Portuguese Government, through the National Road Board, proposed a bridge of suspension type with a central span of 850-ft. but permitted tenderers to submit alternative designs of their own. Tenders were obtained from leading constructional firms on the Continent, from America and from the United Kingdom.

In view of the strong nationalist sentiment in Portugal, Messrs. Dorman Long the British Constructional Engineers tendered in association with the Portuguese firm of Seth (Sociedade de Empreitadas e Trabalhos Hidraulicos), working in close collaboration with the Danish contracting firms of Hejgaard and Schultz A/s and Kampmann, Kierulff and Saxild A/s. The British firm undertook the supply and erection of the steel superstructure and Seth the bridge approaches, piers and foundations and roadway construction.

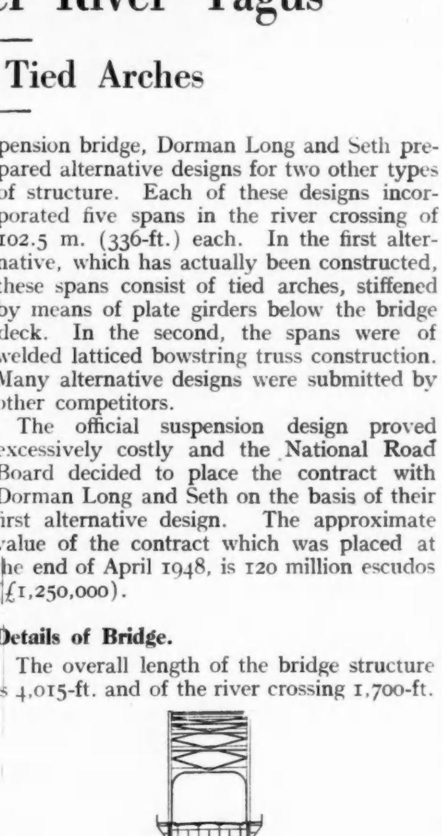
Many Designs Submitted.

In addition to a tender for the official suspension bridge, Dorman Long and Seth prepared alternative designs for two other types of structure. Each of these designs incorporated five spans in the river crossing of 102.5 m. (336-ft.) each. In the first alternative, which has actually been constructed, these spans consist of tied arches, stiffened by means of plate girders below the bridge deck. In the second, the spans were of welded latticed bowstring truss construction. Many alternative designs were submitted by other competitors.

The official suspension design proved excessively costly and the National Road Board decided to place the contract with Dorman Long and Seth on the basis of their first alternative design. The approximate value of the contract which was placed at the end of April 1948, is 120 million escudos (£1,250,000).

Details of Bridge.

The overall length of the bridge structure is 4,015-ft. and of the river crossing 1,700-ft.



Cross-section at River Spans.

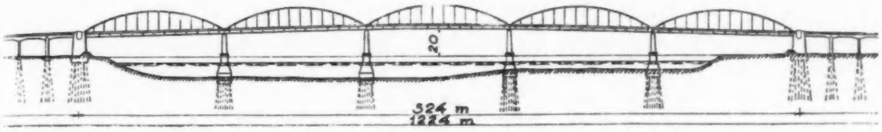
It is the largest bridge in Portugal and ranks among the major bridges on the Continent; it carries a roadway 9 m. wide and two footways each 1.5 m. wide and is designed for heavy highway traffic. Each approach consists of an earth-filled embankment followed by a section of reinforced concrete viaduct with spans of 20 and 25 m. on concrete piled foundations. Piles up to 35 m. long were required. The river is approximately 500 m. wide at the bridge site, with a bed consisting of soft silt of varying consistency for depths of up to 30 m. below water-level, below which a layer of sand and gravel provides a reasonable foundation.

Description of Works.

At the site of each river pier the silt was dredged out to a suitable depth and sand filling deposited in its place. Large hollow reinforced concrete piles, each capable of supporting a load of 120 tons and up to 24.5 m. long, were then driven to a bearing through the silt and into the sand and gravel layer, and left projecting through the sand filling on the river bed. A pneumatic caisson of reinforced concrete which forms the base of each river pier was floated out and sunk over the projecting tops of the piles by admitting water as ballast. The water was then forced from the working chamber by air pressure and the space between the underside of the caisson and the tops of the piles was filled solid with concrete. The caissons were built and launched in a floating dock specially constructed for the purpose by the contractors, and on completion of the concreting of the working chamber, the upper compartments of the caisson were filled with concrete and the pier shaft was then built up to its full height.

The weight of steel in the five arches of the bridge superstructure is just over 3,000 tons of which approximately 57 per cent. is high tensile steel. All the steel was supplied from the Dorman Long Works at Middlesbrough. Two of the spans were fabricated at the Dorman Long Bridge and Constructional Works at Middlesbrough and the remaining three by Braithwaite and Co. Ltd. at West Bromwich. The fabricated steelwork was shipped to the site and unloaded at the contractors' wharf at Vila Franca, from whence it was transferred to the stockyard. The whole of the erection was carried out by Dorman Long.

New Bridge over River Tagus—continued



Elevation of the Main River Spans of new Tagus Bridge.

Each of the arch spans of the river crossing weighs 600 tons. Their erection presented a difficult problem since the river bed is so soft, and the depth to good ground so great, that a normal type of falsework or scaffolding for the support of the spans during erection would have been very costly. The type of spans employed do not lend themselves readily to cantilever erection. It was finally decided to employ a scaffold to support the permanent span during its erection in the form of a steel service span which could be floated into each opening in turn and left with no other support than the narrow shelf at the base of each pier shaft. Once the service span had been floated into position and landed on the piers, packings of appropriate height were laid out on top of it and the permanent steelwork was assembled upon them by a 7½-ton loco crane. On completion, the permanent span could be jacked up at each end from the pier tops, the packings removed and the span lowered on to its bearings on the piers.

The operation of the scheme was complicated by the fact that while the length of each opening of the bridge is the same, the height from the water to the underside of the steelwork varies throughout. The tidal range is up to 4 m. at the site, which is subject to strong winds and tidal currents. The service span weighed 380 tons and had an overall length of 325-ft. The clearance between the ends of the span and the bridge piers was necessarily small. To manœuvre such a span into position and to land it with precision upon its bearing at the base of each pier shaft under conditions of wind and tide involved quite severe problems of navigation. The conditions were even more difficult when the service span was removed from one opening for transfer to the next, for at that time the permanent steelwork had been completed above it and was supported upon jacks from the tops of the piers. By raising the span on jacks from the tops of the piers and removing the packings upon which it had been built, sufficient clearance could be provided between its underside and the top the service span for the removal of the latter. If, however, any delay were to take place in the removal of the service span on a rising tide it would inevitably be trapped between the water and the underside of the permanent steelwork with disastrous consequences.

Two 500-ton capacity steel pontoons were provided for the transport of the service span. These had to be towed to the site from Rotterdam and their hulls specially reinforced to carry the heavy concentrated load of the service span. Upon and between them a steel superstructure was built up, the height of which could be varied to suit the clearance in the various openings. The service span was originally assembled upon this superstructure at the contractor's wharf. The pontoons, carrying the span, were then towed out and manœuvred into position opposite the first bridge opening. At this point moorings attached to the river bed and the adjacent piers were taken up and the whole outfit was warped into position between the piers at slack water at low tide. Water was then admitted to the hulls of the pontoons sinking them sufficiently first to land the service span on its bearings on the piers and then to lower the pontoons clear of its underside. The pontoons with their superstructure were then withdrawn by their moorings and removed, leaving the service span in position.

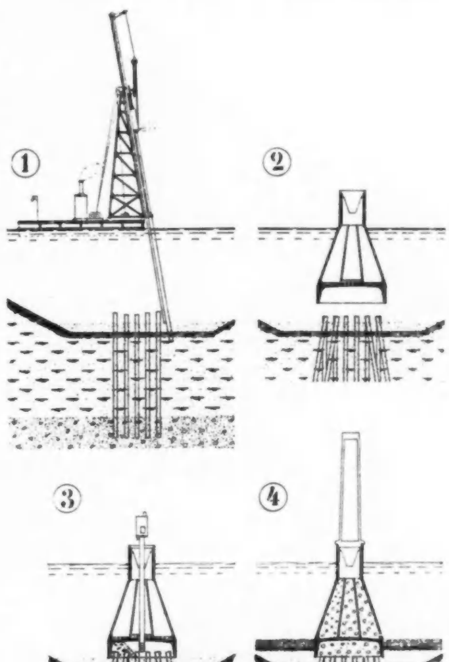
For the removal of the service span after the completion of the permanent span above it, the whole operation was reversed. As soon as the weight of the permanent span had been transferred from its temporary supports to the piers, all packing etc. on top of the service span which might interfere with its removal was cleared away. The pontoons with their superstructure were warped into position below the span at low tide already flooded to the fullest extent. The water ballast was then pumped from the pontoons by large steam pumps allowing them to rise and make contact with the underside of the service span. Accurate adjustment of the moorings and special centring and locking devices ensured that the pontoon superstructure made contact with the underside of the span at the correct points. As further water-ballast was pumped from the pontoons, the weight of the service span was transferred from the piers to the pontoons. When this transfer was complete, the pontoons carrying the span were warped out clear of the piers and the completed span between them. The whole operation had to be carried out as rapidly as possible to avoid the possibility of the service span being trapped between the pontoons and the underside of the completed permanent span by the rising tide.

The completed programme of erection depended upon these complicated operations being carried through smoothly, as any damage to pontoons or service span would have held up work and seriously delayed completion of the bridge. Though on several occasions it was necessary to postpone the transfer of the span, due to strong winds or unfavourable tidal conditions, the operation of moving the service span in and out of each of the five openings in turn proceeded without any mishap.

Great attention was paid to the preparation of the steel of the bridge for painting. The success of any painting treatment depends mainly upon the application of the initial priming coat to the bare clean metal, from which all rust and mill-scale must be removed. In this case the steelwork was sent to the site and stacked in the stockyard unpainted to allow time for the natural weathering action to loosen the mill-scale. The whole of the steelwork was then cleaned by blasting it with sand and compressed air until the surface was perfectly clean. The priming coat of paint was then applied within a few hours of the completion of the cleaning process, followed by three further coats of paint.

The contract with the National Road Board allowed a period of 1,000 days for the construction of the bridge, and the contractors were successful in completing the work within this period.

Apart from about a dozen Dorman Long Bridge Department keymen, local labour was employed on the site. The contract, however, secured valuable employment for the Bridge Department design staff, the fabricating shops and Steelworks of the Company in Middlesbrough. Mr. J. F. Pain is manager of Dorman Long Bridge Department and a director of the Company. Mr. W. Cardno, the agent at Vila Franca de Xira, and Mr. D. H. Field, the engineer on the site.



Construction of River Piers.

1. Driving tubular piles for foundations of river piers with floating pile driver.
2. Floating river pier caisson shell into position over piled foundation.
3. Sealing space between roof of caisson and projecting pile heads with concrete under air pressure.
4. Caisson sealed and concreted and pier shaft completed.

Containers for Cargo Handling

Work of the International Container Bureau and the Possibilities of Containers

By CHARLES F. KLAPPER, A.M.Inst.T.
Permanent Regional Delegate for Great Britain of the International Container Bureau.

Founded originally in 1933, the International Container Bureau, after the lapse of its activities during the war, was revivified and set up on a very sound basis in 1948. Its offices are in Paris at the headquarters of the International Chamber of Commerce; this facilitates meetings for Continental delegates and also enables various valuable services, ranging from the supply of rooms for meetings to provision of interpreters, to be provided economically.

The principal objects of the I.C.B. are to call the attention of traders and transport operators to the advantages of containers; to exchange information between members as to new devices and new applications; and to overcome hindrances to the free passage of containers from one country to another or from one system of transport to another. One of the Bureau's first activities in 1949 was to search for a concise definition of what was meant by a container, so that there should be no doubt from a legal angle as to its nature for the purposes of customs authorities or of transport undertakings which grant special rates for container transport. The description finally accepted runs thus:

"A container is a device designed specially for the transport by any method of locomotion—or a combination of them—of goods in bulk or lightly packed, without intermediate handling or transhipment. It must be strong enough to sustain a considerable number of journeys without needing overhauling; its shape and capacity must allow for its rapid and easy handling and offer complete protection against damage to its contents; it must be designed in such a manner as to permit its being quickly loaded; neither nails, bolts nor hooping must be employed to close it and its contents must be secure from pilferage. This receptacle, to be considered as a container, must have an inside volume of not less than 1 cubic metre. For thermically insulated containers, the volume of the insulating material is included in this 1 cubic metre limit."

Another valuable preliminary task was a census undertaken to ascertain the numbers and types of containers in use in Western Europe. This was carried out on January 1, 1949, and the stock of containers was ascertained to be in excess of 75,000. It was thought that some had escaped the net through belonging to firms that were not members of the I.C.B. But of those enumerated only 53,000 complied with the regulations of the International Union of Railways as set out in the Union's leaflet U.I.C. No. 111; no fewer than 22,000 were thus suitable only for internal service in the country of origin. By January 1, 1951, when a fresh enumeration was made, there were roundly 106,000 containers in Western Europe.

The largest stock of containers in one ownership was that of British Railways—nearly 24,000 and nearly all of U.I.C. standards. There were only about 1,200 privately-owned containers returned in Britain, whereas in France private owners accounted for 28,000, the S.N.C.F. (French National Railways) stock being only about 6,000. Fewer than 10,000 of the containers owned in France complied with the U.I.C. standards for international traffic. With a large wine trade the French led in the number of tank containers, having over 12,000. Incidentally, many of these are engaged in the ship to rail transfer for crossing the Mediterranean from North Africa.

Britain, France and Holland proved to be the only countries where open containers were in vogue; in this country they are used for building materials and other commodities impervious to the weather, while most of the Dutch open units are engaged in coal traffic. Britain led in refrigerated containers, with over 3,900 out of a total of about 4,500; as a result of this revelation in the first census the transport authorities in several other European countries have investigated the possibilities of their use and some have begun developments. The 1949 census also revealed that 10,000 of the 19,000 containers in Western Germany were only just over the minimum size of 1 cubic metre; in the past two years the German railways have taken up the development of larger containers, having become fully seized of their possibilities in the reduction of handling costs, and 6,200 are in course of delivery. The D.A.F. method of winching them between lorry and railway wagon, originated by Van Doornes in Holland, is being adopted in Germany, as it has been in Belgium and Switzerland. It is of interest that the census check taken on January 1, 1951, showed a 40 per cent. increase in the European container fleet in two years.

To encourage container traffic between the various countries of Europe, the I.C.B. has vigorously taken up the matter of securing necessary modifications of the U.I.C. regulations. Having agreed on matters of construction and design, and taken cognisance of the needs of customs authorities with the international railway organisations the next step has been the securing of approval of governments, through the Berne Convention machinery and that of the United Nations at Geneva. This is necessarily a lengthy procedure, but it is hoped that progress will be made during 1952, after the many conferences held in 1949-50 to secure agreement as to both road and rail requirements.

On the shipping side it cannot be claimed that anything like this amount of progress has been made. This is perhaps curious, because although a prototype of the road-rail container was in use in the Liverpool and Manchester Railway in 1830, the first containers of modern times were all introduced on short sea journeys; one application was for passengers' registered luggage between London and Paris via Dover-Calais, while the other—initiated by the London and North Western Railway in 1921—was for general traffic between London and Belfast and really marked the beginning of modern development of the container, which became fully established in Britain in the late 1920's.

Nevertheless, the fact remains that despite a certain amount of experimental work having taken place with certain companies, British shipping lines are relatively indifferent to the container. Port authorities, also, are somewhat unwilling to give the container its due by reducing their dues in favour of traffic conveyed by container, despite the efficiency a volume of container traffic promotes in a port. Some French ports have recognised this and make a concession similar to that made by railways, charging the net weight of the goods and providing for free or cheap return of the container.

Shipping managements, on the contrary, demand a charge on the gross weight of goods and container and as a result of the high charges on returned empty containers, it is often cheaper to leave them to rot on the quayside in the destination country than to retrieve them. To reduce returned empty charges collapsible containers have been introduced; some promising French designs pack into one-third of the space they occupy when loaded. The Safrap is a particularly solid unit which is understood to have stood up well to dismantling (without any of the smaller parts, each of which has a place in the collapsed container, becoming lost) when engaged in the trade between France and Algeria. Moreover, it is still recognisably a container and so overcomes the difficulty experienced by the English customs authorities when a set of steel sheet and rod arrived from Holland in a form which they found hard to believe would build up into containers.

Despite the lukewarm attitude of some of those engaged in sea transport and port work—and the extremely difficult attitude of the U.S. customs, who will not permit the temporary import of European containers, so that goods have to be transferred on the quayside into U.S. built and owned containers or other vehicles—the trader can readily discern the advantages of the container. It saves enormous quantities of packing; it saves transhipment; it virtually eliminates pilferage and it reduces damage.

When jute and paper are in short supply the saving of packing looms particularly important. The saving of labour in transhipment must always have appeal while manpower is short, apart from any monetary saving; as to losses, examples show a reduction from 20 per cent. to none in the fruit trade when containers are used; an 80 per cent. reduction of shortages in wine since casks were abandoned for tank containers; and a reduction in loss of cement from 25 per cent. to 0.05 per cent. since transferring the traffic to specially built containers designed for pulverised loads.

Containers for Cargoe Handling—continued

Insurance offices have also been quick to realise the benefits conferred by the container in reducing losses. As a result French marine insurance firms give a 50 per cent. reduction on the tariff premiums for insurance against breakage and theft in the case of traffic conveyed by container. For certain traffics a 75 per cent. rebate is offered if containers are used.

The most striking tribute to the value of the container in port work comes from the United Shipping Company of Copenhagen. This Danish undertaking has large coasting interests, among which is a service operated from Copenhagen to Horsens, Vejle, and back to Copenhagen; the round trip of 347 miles is covered three times weekly by each of two motor vessels, to give a daily (except Sundays) service. These ships, the "Riberhus" and "Axelhus," have each replaced two 500-ton steamers of conventional design, so saving a crew of 20 men and using only 15 tons of diesel oil a week instead of 100 tons of coal. The reason is that the present ships, placed in service in 1950, are specially designed to handle containers and pallets and no other traffic is accepted. The shipping company has a stock of 1,100 wooden containers (with 10 further experimental steel units) and these are placed at the disposal of shippers free of charge.

In normal operation the ships spend a day in Copenhagen and 3½ hours at each of the smaller ports. The service speed is 15 knots. Each vessel measures 210-ft. overall, with a breadth, moulded, of 34-ft. 5-in. and a draught of 12-ft. 3½-in. The deadweight capacity is about 600 tons, gross tonnage being 471. The six-cylinder two-stroke diesel engine develops 1,560 i.h.p. Electric generators provide for lighting, crane operation etc.

The main holds are 120-ft. long, with 31,300 cubic feet and 20,200 cubic feet of capacity respectively. There is a small hold of 3,400 cubic feet under the forecastle. Two Asea 3-ton cranes which travel on the hatch coaming provide the entire lifting tackle required. They are equipped with two motors for travelling and have three other independent motors for luffing, hoisting and slewing. The forward crane can place containers in the forecastle hatch and both can work the main hatch, which is 91-ft. 10-in. long and 21-ft. 3½in. wide. The opening of the hatch is carried out by the cranes, which normally stand at the centre. Their bases form a section of hatch cover and as the cranes move outwards they automatically lift and stack the remaining covers. The tweendeck hatch, giving access to the lower hold, has flush-fitting timber-protected steel covers, so that fork-lift trucks can place containers or pallets in those parts of the hold not directly accessible to the cranes.

Beer traffic is particularly cited as one in which time is saved. Formerly each crate had to be manhandled from the quayside, sent down a chute, and then stacked and secured in the hold. Now 72 beer crates come in a container and all are on board and stowed in under 2 minutes. The containers employed are of 124 cubic feet capacity, measuring 3-ft. 10½-in. by 5-ft. 2-in. by 6-ft. 2-in. The United Shipping Company thinks so highly of the arrangements that replacement of other steamers by these specialised container vessels is contemplated. In those built for this service the height between decks is such that only one tier of containers can be accommodated; an absence of projections on top of containers is normally desirable for marine work in order that they can be stacked, if not in the ship's hold, then on the quayside or in warehouses awaiting dispatch. It is also desirable, as already mentioned, for them to be collapsible if they are liable to have to return empty.

The International Container Bureau, which has some 70 members and 15 associate members in Belgium, France, Germany, Great Britain, Italy, Netherlands, Portugal, Spain, Sweden and Switzerland, comprising rail, road, sea, air and canal transport undertakings, container builders, transport users and forwarding agents, can be relied upon to press the cause of the container and to continue to point out why it should enjoy favourable consideration from port authorities and shipowners when rates and charges are being fixed.

Liverpool Observatory and Tidal Institute

Excerpts from Annual Report for 1951

During the year there has been some discussion of the relation between the Tidal Institute and the newly-established National Institute of Oceanography. The important part played by the tides in many oceanographical phenomena obviously made it desirable that the fullest co-operation between the two institutions should be envisaged. The director, Dr. A. T. Doodson, is one of the representatives of the Royal Society, and Professor Proudman is a representative of the Universities, on the National Oceanographic Council, which is responsible for the National Institute, and a revised agreement has been made between the Mersey Docks and Harbour Board and the University of Liverpool so as to provide for one of the members of the Governing Committee being nominated by the Oceanographic Council. Dr. G. E. R. Deacon, the director of the National Institute, has been appointed.

While there are many researches in hand, only one paper has been prepared for publication namely, "A determination of the earth-tide from tilt observations at Bidston and Bergen," by R. H. Corkan. This paper applies a new method of determining the earth-tide, that is, the yielding of the earth itself to the tidal forces, from observations of the tilt of the ground at two places. Observations of the tilting of the ground at Bidston, made in 1909, were largely attributed to the local effects of the weight of tidal water, but in 1933 more exact observations were obtained and analysed for tidal constituents. It was found that there was not an exact correspondence with the local tide and that the discrepancy was due to the internal yielding of the earth. By assuming that the observed results were derived from a simple multiple of the local tide, and from an internal tide instantaneously related to the tidal forces, it was possible to determine the magnitude of that internal tide. Other investigators have elaborated methods of correction for the load of the tide over large areas, but Dr. Corkan realized that such elaborate and possibly uncertain methods were not necessary if two stations could be used, and that from data at two stations it was theoretically possible to determine the lag of the internal tide with respect to the generating forces. The stations at Bergen and Bidston have been chosen to illustrate the method. It is necessarily assumed that at the two places the earth-tide has the same characteristics, which may not always be true, but the method will add to our knowledge of the earth-tide, which can only be deduced indirectly from observation.

Considerable attention has been paid in past years by the director to the problem of tides in oceans bounded by meridians from pole to pole. The problem of oceans which are not wholly bounded but whose meridian boundaries only exist between certain latitudes has not yet been solved, but great efforts have been made to solve the problem. Finite-difference methods have been applied, leading to a set of about 60 simultaneous equations, and two methods of solving these have been tried. One method led to very large numbers occurring in the equations after eliminating two-thirds of the variables, while another method led to very small numbers. There is thus some instability in the mode of solution, and so methods of attack other than those of finite-differences are being investigated. The problem is of importance in throwing light upon an open ocean such as the North Atlantic ocean, and on the pitfalls in the application of finite-difference methods to an actual ocean.

Another fundamental research, on the oscillations in a rotating square sea, has been nearly completed by Dr. Corkan. He has applied the methods of "relaxation" to investigate free periods and modes of oscillation; these methods provide a finite-difference solution and it is easily possible to allow for high degrees of approximation. The ultimate object of this work is the application of similar methods to the free and forced tides in actual seas and the introduction of additional theory into the methods used in the preparation of cotidal charts.

Liverpool Observatory and Tidal Institute—continued

The results have resolved several of the differences between the results of previous investigations. In the case of the square sea there are at least two distinct normal modes of oscillation; one member of each of the pairs of modes is a wave travelling round the basin in the directioin of rotation (positive wave), and the other member is a wave system travelling in the opposite direction (negative wave). The periods and modes for the lowest frequency of both wave systems have been determined numerically for all rotations.

The positive wave is at all times a comparatively simple rotating system with an amphidromic point in the centre. For small rotations, the negative wave is also a simple rotating system with an amphidromic point in the centre. For larger rotations additional amphidromic points come into existence, first at the centres of the sides and then gradually towards the centre of the sea, and the development of the rotating systems has been traced as rotation becomes ultimately infinitely large.

Work at sea was continued for five weeks in the summer, in association with the University Department of Oceanography. Observations were made at the same stations north of Anglesey as in the previous year, in a resumed attack on the problem of relating the tidal streams to the gradient of the sea surface, and to the friction at the bottom. The streams were measured with one of the Doodson current meters, which functioned satisfactorily throughout.

The main difficulty in the previous year had been insufficient accuracy in the time scale of the Favé-type pressure gauges used for recording the tidal elevations. To overcome this, the gauges were modified by Mr. Bowden so that the clock in the gauge put time marks on the record every hour. In addition, time marks were put on electrically through a cable passing from the boat down to the gauge after laying it and again before raising it. The results were a great improvement compared with the previous year's, repeated sets of observations giving amplitudes consistent to about 1 cm. and phases to $0{\cdot}1^\circ$ (about 12 seconds of time).

The observations are still being analysed by Mr. Bowden but preliminary results indicate that bottom friction has an appreciable influence on the tidal streams in this area and its magnitude is of the order anticipated. If the complete analysis confirms these results, this will be the first time that the effects of bottom friction have been established experimentally for a small area of sea, over which the gradients and streams may be taken as nearly uniform, as distinct from general deductions for large areas.

International Union for Geodesy and Geophysics.

The Director and Dr. Corkan were British delegates to the conference of this scientific union in Brussels during two weeks in August. The Director, as a member of the Financial Committee, devoted much of his time and energy during the conference to the finances of the Union and was continued on the Committee at the concluding session of the conference. He also took an active part in the discussions of the Association for Physical Oceanography. The most valuable part of the conference was in the opportunities for informal discussion of tides. Dr. Corkan and Mr. Bowden (of the University Department of Oceanography) gave papers, the former on storm surges and the latter on the results of the experimental work done at sea, and on turbulence.

It was regretted that Professor Proudman, vice-president of the Association for Physcal Oceanography, was not able to be present at the meetings, as he has usually taken a very active part in them, which was recognised by his election as President for the next triennium and for the next conference in Rome, 1954.

Dr. Corkan was re-elected Secretary of the Committee for Mean Sea Level, and arrangements were made for extended activities of this important committee. He was also appointed Recorder on the subject of Earth-tides.

Visits to Hamburg, Ghent and Antwerp.

Prior to the aforementioned conference, the Director visited by invitation the German Hydrographic Institute in Hamburg. He was greatly interested in the large tide-predicting machine and in the deep-sea apparatus for recording tides and waves. The discussions with the staff of the G.H.I. were of great interest and value, as their research activities are on similar lines to ours.

A visit was made to the large open-air model of the River Elbe, which is about 400 metres long. In view of the Director's criticisms of the scales of water-models and of the effects of exaggeration of the vertical scales in under-estimation of the frictional forces, it was of very great interest to him to note that the fixed bed (that is, without moving silt or sand on it) was studded with projections to give the necessary degree of artificial friction. He was privileged to be shown curves demonstrating the remarkable effects of these projections on the tidal curves, whereby a very poor representation of the tides, in the absence of friction, was converted to a very excellent one. That this was so even with a distortional factor of 10 was a justification of the Director's arguments against models with even greater distortions.

The Director also visited hydraulic laboratories at Ghent and Antwerp, and was particularly interested to note that a large model of the River Scheldt in the latter laboratory also demonstrated the great efficiency of artificial friction. What he had shown from theory, that no model with a largely exaggerated vertical scale can give an exact representation of the tides without some exaggeration of frictional losses in the model, was thus completely verified by these empirical demonstrations.

Obituary

Dr. R. H. CORKAN

The death of Dr. R. H. Corkan, Deputy-director of the Liverpool Observatory and Tidal Institute, at the early age of 45, has brought to a close a career of high attainment and of much promise for the future. He was a native of the Isle of Man and completed his education at the University of Liverpool, where he obtained an Honours degree in mathematics. He was then selected as scientific assistant at the time of the transfer of the Tidal Institute from the University to the Observatory in January 1929.

His first research work in association with Dr. Doodson led to the construction of cotidal charts for the English and Irish Channels in continuation of a similar work by Proudman and Doodson for the North Sea, and all these are combined in the Admiralty Chart of cotidal lines for British waters. Again working with Dr. Doodson, the next research dealt with the yielding of the earth to the load of tidal waters and also directly to the attractive forces of sun and moon, and this work had been followed up by him up to the present time. He published papers on the Bore in the Trent, tides near Graham Land and on analytical problems.

The war put a stop to many of his tidal researches and he was transferred on loan to the Admiralty and for some time he worked at the Nautical Office where he shared in many very useful activities. He visited Ceylon and India as Liaison Officer on tidal problems. After the war he resumed his interest in the storm surges experienced in the North Sea. The disastrous floods in the Thames, in January 1928, led to Mr. Doodson being asked to investigate the causes and this work was followed up by Corkan in a very comprehensive manner. The earlier results were confirmed and methods of calculation were elaborated for many types of barometric distribution, and the result was that a full report was prepared for the London County Council, the Port of London Authority and others. A brief description of this work was published in this Journal (Volume XXVIII, February 1948, page 226), and the whole report in two volumes was photographically reproduced by the United States Hydrographic Department and distributed in that country. It is to be regretted that it was not published **in extenso** in this country. This work was being continued for other seas, together with other researches, when he was taken ill.

Dr. Corkan also had mechanical skill and shared in the upkeep, modification and construction of many of the machines and instruments used at the Observatory and he shared in the research work carried on at sea, so that he had all-round capabilities of a high order.

He took his degree of D.Sc. Liverpool in 1950 and he leaves a wife and one daughter.

Slow Working at N.Z. Ports

Factors affecting Turn-Round

The Annual Report of the New Zealand Waterfront Industry Commission for the year ended March 31st, 1951, which was published last autumn, says that the year was marked by the most serious dispute which had ever developed on the New Zealand waterfront.

After analysing the figures relating to the time spent in New Zealand ports by vessels from overseas, the Report gives details of the factors affecting the turn-round of shipping, the chief of which are as follows: Rates of work; overloading of port facilities; shortage of railway trucks; multiplicity of marks; shortages of labour; spelling; and loss of man-hours on the waterfront.

Rates of Work. The all-port average rate of discharging general cargo from overseas vessels increased slightly from 11.47 tons per net gang-hour for 1949-50 to 11.73 tons for 1950-51. The rate of work at Auckland was only 9.65 tons per net gang-hour, as compared with 14.56 tons for Wellington, 12.31 tons for Lyttelton and 12.41 tons for Dunedin. There was a general falling off throughout the country in the rate of loading mutton and lamb, due to the cessation of telescoping at the beginning of the previous export season, the decrease being from an average of 833 carcasses per net gang-hour for 1949-50 to 785 carcasses for 1950-51. The rate of loading frozen sundries of meat fell from 476 freight carcasses per net gang-hour in 1949-50 to 457 freight carcasses in 1950-51. There was a small increase in the rate of loading butter from 723 boxes per net gang-hour in 1949-50 to 732 boxes in 1950-51. The rate of loading wool increased slightly from 80 bales in 1949-50 to 82 bales in 1950-51.

Overloading of Port Facilities. During 1950 a total of 8,961,000 tons was handled, which represents an increase of 325,000 tons on the previous year and an increase of 1,278,000 tons over the cargo handled in 1946. Compared with the year ended December 31st, 1938, the tonnages handled at New Zealand ports during 1950 show an increase of 796,000 tons, and of this increase 594,000 tons was handled at the port of Auckland.

Due to the shortages of labour and materials, harbour boards, particularly at Auckland, have not yet been able to increase berthing space and shed accommodation commensurate with the increase in cargo handled. The Auckland Harbour Board has recently let a contract for the erection of a new bulk wharf, and when this wharf is available congestion at the port should be alleviated.

Shortages of Railway Trucks, particularly at the ports of Lyttelton and New Plymouth, were again experienced during the year, resulting in interruptions to work. When orders, at present in hand, are completed, it is anticipated that there will be a sufficient number of all types of wagons to meet requirements.

Multiplicity of Marks. The Report states that some progress has been made in the problem of multiplicity of marks during recent years, but there is still room for considerable improvement.

Shortages of Labour. Where shortage of labour is concerned, it is observed that during the year the numbers on the Bureau registers were increased at the ports of Wellington, Auckland, Dunedin, Napier and New Plymouth, and these increases largely overcame the shortages of labour which existed during 1949-50. It is not possible to provide a labour force at each port sufficient to meet the rush periods of shipping, but every endeavour is made during such periods to supplement the normal labour force with casual non-union labour. Prior to the waterfront strike, "spelling," or the working of hour about, was still practised on the New Zealand waterfront, particularly at Auckland, Wellington and Lyttelton. One of the conditions laid down by the Government for the resumption of work under the separate port unions was that "spelling" was to be abolished. It is gratifying to record that "spelling" has now ceased on the waterfront throughout New Zealand, and at most ports the employers have granted to the workers fixed breaks for smoking during the morning and afternoon, for which they are paid.

Loss of Man-hours. The total man hours lost through stoppages of work during the year amounted to 2,889,678 hours, compared with 591,624 hours for 1949-50 and 294,616 hours for 1948-49. The percentages of man-hours lost through disputes in relation to the total hours worked was 20.24 per cent. in 1950-51, 3.83 per cent. in 1949-50 and 2.25 per cent. in 1948-49.

The high incidence of man-hours lost as a result of stoppages of work is reflected in the corresponding decrease in the hours lost through accidents on the waterfront. Hitherto the man-hours lost through accidents have been in excess of the man-hours lost through disputes involving stoppages of work, but 1950-51 is the exception.

The average hours of work per week (ordinary and overtime) for all main and secondary ports was $43\frac{1}{4}$ (32 ordinary, $11\frac{1}{4}$ overtime) for the year, compared with $44\frac{3}{4}$ ($33\frac{1}{2}$ ordinary, $11\frac{1}{4}$ overtime) for the previous year. This reduction of $1\frac{1}{2}$ hours in ordinary time is consistent at all main ports and most secondary ports. The reduction in the number of average hours worked per week is accounted for to a large extent by a substantial increase in union membership at all ports from 6,830 in December, 1949, to 7,435 as at February 14th, 1951.

Average Weekly Earnings. The all-ports average earnings per man-week increased by 6s. 9d. to £12 4s. 1d. The average for the year 1948-49 was £11 1s. 2d. Hence in two years there has been an increase of £1 2s. 11d. per man-week worked in the all-ports averages of unionists' earnings. The average for the year under review as compared with the previous year is affected by the increase in basic hourly rate of pay of 3d. per hour from 4s. to 4s. 3d. per hour granted by the Waterfront Industry Authority as from May 8th, 1950.

The Human Aspect in Dock Delays

Need for a New Approach

(By a Special Correspondent)

Delay in the turn-round of ships in port is now generally recognised as a blight which has descended on docks and harbours all over the world, with some notable exceptions. It has come to be accepted as almost inevitable. "We are back in the horse and buggy stage," cried an American despairingly not long ago. "Our ships," a British shipowner said, a little more picturesquely, "used to be sea monsters which occasionally came to shore; now they are shore monsters which occasionally go to sea."

Can anything be done to remove the blight—and, if so, what? Last month the *Dock and Harbour Authority* published the memorandum drawn up by the International Chamber of Shipping on delay in turn-round. The statement has been criticised here and there for being "vague." But it could hardly have been more precise and at the same time honest. It was an expression of views "on the wide field of issues involved," and the conclusion arrived at—and it is difficult to see what other could have been reached—was that very largely the solution of the problem of delay must be found through local and national action.

Let us therefore look at it from that angle, realising that even if in this country some remedy could be magically conjured up, there would still remain the rest of the world to conquer. If we study the I.C.S. document we shall see that it can be divided into two sections—the purely physical, and the human aspect. The skilled brains of practical men have been largely focussed on the physical side, so that it may be said, in a general sense, that given the necessary money and materials — and the goodwill to use them — docks could be modernised, installations improved, mechanised aids introduced and all-round efficiency promoted.

And then, what?

If every dock in the country were made 100 per cent. efficient, the last state might still be as bad as the first; all would be as "sounding brass and tinkling cymbal" without a corresponding 100 per cent. co-operation from the dock workers. The statement is so obvious as to be trite, yet too many people shy away from this angle—perhaps because of all angles it is the one with the sharpest sides and points. Some, in exasperation, lay the whole of the blame for present delay on the dockers, which is unfair. Others, resigned to the belief that it will take ten years at least to bring about a change of mind, heart and outlook in dockland, look to "discipline" to cure current maladies. The idea of "educating" the dock workers is only slowly finding expression.

The Human Aspect in Dock Delays—continued

The I.C.S. statement sets out six items under the heading of "Labour problems," and it may be well to consider them. They are:

1. Shortage of labour at peak periods;
2. Restrictive practices;
3. Failure to make maximum use of existing mechanical appliances.
4. Disadvantage of pooling, i.e., dilution of specialised gangs, loss of personal interest in the job;
5. Opposition to overtime or to shift-working or to incentive payments.
6. Indifferent discipline due to various causes.

Of these six points, the writer is only concerned in this article with the second and third; the others may be said to come under the heading of administration. Taking "Restrictive practices" first, one needs to know whether these result from the dock worker's own attitude of mind—i.e., are legacies of a past period of bitter relations between the two sides of the industry, or are brought about by subversive influences. In the result the remedial action will be the same—education—but the approach will need to be different. To "Failure to make maximum use of existing mechanical appliances" ought surely to be added "and to resist the introduction of new" for, unhappily, that is still the tendency.

It has been said again and again that the dock worker lives in a state of partial isolation from the rest of the community. His loyalty to his fellows is as admirable as it is often misconceived. Strike first and inquire after is frequently his reaction to fancied injustice to himself or to one of his mates. He belongs to that section of workers with bitter memories of the past who see in every invention to speed up output a cunning device on the part of the employer to exploit the employee, and see, too, the threat of unemployment looming up because the quicker the work is done the less there will be to do. It is a simple reasoning which takes little account of industrial history.

In the newspapers not long ago one read of a new gear-cutting machine in a motor-car factory which could cut an incredible number of gear wheels at one operation. One did not read of any protest from the workpeople at the installation of this labour-saving device. Clearly it was appreciated that speed in the production of parts of cars meant the production of more complete cars; and with demand far outstripping supply there was no fear of unemployment. Indeed, such idleness as has recently been forced on the motor-car industry has been due to shortage of materials, owing to the rearmament programme.

In the case of dock workers the demand for the commodity with which they are concerned—ship space—is so clamant and persistent that quicker turn-round of vessels would mean acceleration all along the line from factory to consumer, with immeasurable benefit to everyone, consumer as well as producer. The first point, therefore, about which the dock worker has to be convinced is that restrictive practices are anti-social, and that mechanisation is to his advantage.

Before a doctor prescribes a remedy he has to diagnose a disease, and to be fully informed of all the patient's symptoms is the first step. What *are* these restrictive practices about which so many people speak glibly, often with little knowledge? The time has surely come when they should all "be known and conned by rote," tabulated in detail, and boldly submitted, item by item, to a jury drawn from the interested parties. It may well be found—to the astonishment of all—that some of these old practices are so puerile, so out-dated, that they can be thrown overboard without loss of "face" or anything else. Others, perhaps, may be more jealously clung to because they represent some fancy form of protection against the bad employer. In this age of conciliation it should not be impossible to substitute for out-worn restrictions some agreed rules which would safeguard the worker, and guarantee the employer against the risk of sudden dislocation of schedules.

A Grand Inquest is called for. Unlike most inquests, however, it may be desirable to hold this particular inquiry in private. There may have to be some straight talking and some hard bargaining, so that it would be better to avoid any temptation to play to the gallery, score debating points or seek to "hit the headlines" such as would be provoked if the full blaze of publicity were turned on to the discussions. It might not be a bad idea to have all the facts made known beforehand; some quite interesting and fruitful suggestions might be forthcoming from the public who, after all, are the chief sufferers. But the actual inquest should be behind closed doors.

The next point to be considered is the dock worker's reaction to mechanised equipment. Here, it is submitted, the importance lies in the fact that mechanisation has a double aim—to *help* labour and to *save* labour. The dock worker, in his present suspicious mental attitude, cannot be expected to develop enthusiasm for some machine which is only going to save labour, unless he can be convinced that saving labour really means in the end employing more labour because of the wider spread of overhead expenses. He might, however, become interested in the other aspect, that the machine can make his own job easier.

Not long ago, at an adult residential college, a lecturer was asked whether the resistance of dock workers to the use of mechanical aids was not a disservice to the nation. There were one or two dockers in the class and the lecturer had to be tactful. Having given a carefully-phrased answer, he drew a fanciful picture of a white-collared dock worker of the future simply pressing buttons and pulling levers and letting a machine do all the disagreeable work. He ended by saying that he personally would always vote 100 per cent. for anything that would "take the weight off his feet," or the "ache from his muscles." To his surprise he found the dock workers loudly applauding his sentiments, and was led to meditate that the soil may, after all, if properly tilled, be ready for the seed.

The shipowners who drew up the I.C.S. statement were not prepared to go beyond the general assertion that, where the human factor is involved, every opportunity must be taken, whether locally, nationally or internationally, to secure a fuller realisation by all those who repair, load or discharge ships that, not only as workers in the repair yards and in the ports, but also as members of the community at large, they have much to gain and nothing to lose by an improvement in output.

"Every opportunity must be taken . . ." Is, in fact, every opportunity *being* taken? Exhortations and resolutions, whether passed at national conventions or local meetings, are sterile; it is doubtful if they ever reach the dock worker. If they do, he is so tired of being made the target of declamations, so exasperated at being singled out as the villain of the piece, that he takes no notice of them. There needs to be a more intimate, a more human approach.

Up and down the country are to be found earnest, thoughtful men who are bringing a new meaning to education. They are the leaders of adult educational schools and colleges — the workers' equivalent of the old "summer schools." To them go men drawn from many different walks of life to study their own calling and to learn something of a wider range of subjects. They live together, often in an old country house, eat together, question and argue together; getting to know by these means the other man's point of view, his reactions to the problems of the age. It is an intriguing adventure. May not these schools be one of the ways of breaking down the traditional "isolation" of the docker?

So far not many dock workers have been drawn into these courses. In any case only a few could be taken at a time, and it would require years for the leaven to work. But as no one would suggest that the solution of the problem of delay in ports is going to be anything but a long-term task, time is a factor which, perhaps, ought not to weigh too heavily on the mind.

The dock worker, brought into direct contact with others of his fellows, in surroundings far different from those to which he is normally accustomed, may learn (to his surprise, maybe) that there are other loyalties besides that of "standing by" his class. He may learn, too, something of economics, and realise that he is not, and cannot be, someone apart from the community; that he cannot have a code of conduct offending against the modern concept of social life.

Contact with one's fellows certainly broadens the mind. It is said that after the dinner given to the builders of Grays Inn hall by the benchers of the Inn recently, one of the men who had

(Concluded at foot of next column)

Book Reviews

Earth Dams (Les Barrages en Terre) by Ch. Mallet and J. Pacquant, published by Eyrolles, 61, Boulevard Saint-Germain, Paris, Ve.

The prime necessity for any community is sweet water and therefore the collection and storage of ample supplies in all seasons entails considerable preoccupation and expense. The larger storage reservoirs have been constructed by damming the necks of deep valleys in hilly country where material for construction was readily quarried and supplied. In the flatter river valleys distant from any rock quarries other expedients were imperative. The earth dam was thus evolved and experience over the last few decades has shown that almost any kind of soft earth can be utilised provided suitable methods and precautions are taken, moreover with present-day appliances and methods even poor sub-foundation material in a suitable site location can be dealt with satisfactorily.

It is with matters such as these that the book is mainly concerned. The authors are particularly competent to deal with the theory and modern practice and are favoured by the support of Professor Karl Terzaghi who contributes an appreciative preface to the volume. The clarity of the text, the sustained arguments, and the many useful hints on construction are convincing evidence of the author's ability and wide experience. It is a book which should be useful alike to students, contractors and engineers of hydraulics, even outside the field of earth dams.

The first chapter treats generally of the choice of dam shape, materials, and foundations; stressing the need for harmony of arrangement to ensure an approximate homogenity. The authors point out wisely that the careful solution of secondary problems often makes for the efficiency of the main body.

The second chapter deals very completely with the efficient evacuation of floods to avoid the dangers of overtopping. The third chapter is perhaps the one of most importance treating of the infiltration of water and the dangers of even small washouts. The information and advice given should be helpful to those who have to make rapid decisions to deal with floods. The various methods of dealing with infiltration and seepage are discussed and competent attention is given to the relief of pressure by open galleries and filter carpets of various designs. The practical methods of controlling watertightness and the prevention of slips is dealt with in Chapter IV in which many useful practical hints are given.

The final chapters V and VI treat of the structural stability of dams, the selection of suitable materials and the construction. Hitherto little helpful matter on these items has been published in France and the present volume should be welcomed of only for these features.

Pre-stressed Concrete (Béton Précontiainte) by Y. Guyon, published by Eyrolles, 61, Boulevard Saint Germain, Paris Ve. 728 pp. 503 illustrations, price 4704 frcs. (This book is published under the auspices of the Institut Technique du Batiment et des Travaux Publics.)

This compendious well-bound and well printed book deserves to be a best seller of French technical literature. As its sub-title indicates it is a study of the theory and experiments of modern methods of pre-stressed concrete. It is written by an enthusiatic supporter of E. Freyssinet, the pioneer and foremost authority on the subject. M. Freyssinet contributes a forceful preface to the book and gives it his blessing. He adds a note of warning, however, pointing out that this new structural method must be handled skilfully and with understanding simple as the underlying principle may be.

The author has gone to considerable pains to examine step by step the fundamentals of this new technique to obtain structural efficiency in the use of two widely differing materials, concrete and high tensile steel, combined to form more or less homogeneous working members of a structure. The present volume deals with simple freely supported applications and it is pointed out that the more difficult problems will be dealt with in subsequent volumes. The book is divided into three main parts.

First part: The fundamentals of design, the correct materials to use, the resistance to fire, the most suitable constructive methods and precautions are treated in eight chapters. Comprehensive treatment is given to the simple application of the general principles to various forms of structure and various methods are examined. The various grades of steel and qualities of concrete are discussed, besides adhesion, placing of wires, localised stresses at the anchorages and safety factors. Among the important points investigated are the friction of the steel wires in the sheathing, the losses in tension due to stretch, losses due to curved alignments of the wires, the evaluation of the efforts and effects of various forms of abutments for the applied tractive force and the efficient anchorage of the ends of the wires.

Second part. This part is concerned with the application of the elastic theory to beams subject to simple bending. Various forms of section and alignments of cables are considered. The losses by creep of concrete, shrinkage and yield of anchorages in the achievement of a permanent pre-compression in the members of a structure are discussed in five chapters of convincing clarity and range.

Third Part. The five chapters of this section are devoted to the examination of many tests and the application of the results to practical use and security. Ample proof is advanced of the efficiency and reliability of pre-stressed concrete members and structures. An interesting feature is the application to structural members to take the place of timber for house building. The security factors for bending, shear, fissuration and elastic deflection are fully discussed. One chapter deals with the author's suggestion for elasto-plastic computations in the design of pre-stressed members. He gives much useful data for designers. On the whole the book should prove a boon to contractors, engineers and students.

R. R. M.

Publications Received

Water Pollution Research Report.

The annual report on the work of the Water Pollution Research Laboratory during 1950 was published recently by H.M. Stationery Office for the Department of Scientific and Industrial Research (price 1s. 6d., by post 1s. 7½d.). The publication includes the report of experiments carried out on the biological treatment of sewage, and on industrial and toxic waste waters.

The scope of the survey of the Thames Estuary, which was begun at the request of the Port of London Authority to investigate the causes of the deposition of silt, has been extended to include a study of the condition of the water in the Estuary. Records of analyses and examination of the water covering the last 55 years and information on dredging and tidal phenomena are being examined in order to learn the relative importance of the effects of changes which took place in that time on the sanitary condition of the Estuary. Two marked changes which have shown themselves during the period are a steady increase in the temperature of the water and a decrease in the content of dissolved oxygen.

Stone Exposure Tests.

Among the publications issued during October, 1951, by the National Bureau of Standards, U.S. Department of Commerce, Washington, was a 41 page Report on a stone exposure test wall, by Daniel W. Kessler and R. E. Anderson. Stones from 47 states and 16 foreign countries form a wall built at the N.B.S. as part of a long-range investigation of the weathering of stone masonry. The Report describes the wall construction, orientation and exposure conditions of the various stones, and their arrangement in the wall. It gives information on the methods of study used and discusses maintenance of records, and important consideration because of the long-term nature of the project. Copies, price 25 cents, may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington.

The Human Aspect in Dock Delays

been engaged in the reconstruction was heard to say: "Blimey, I never knew before that these ——— judges could be so human!"

The thoughts expressed in this article are rather discursive and theoretical in character. The answer to dock delays may be, as some argue, the provision of more berthing accommodation. If it is really as simple as that, there is nothing very much to worry about. Either the accommodation can be provided, or it can't be provided. But if bound up with this physical, material aspect is the human element, then simplicity fades into complexity. Until we reach the robot age, the dock worker will be with us; imperfect as he may be in some respects he is all we have and we have to make the best use of him we can.

Lighthouses for the Persian Gulf

Automatic Unattended Acetylene Lighting Equipments

A contract awarded to the Gas Accumulator Co. (U.K.) Ltd., Lighthouse Engineers of Brentford, by the Persian Gulf Lighting Service is of unusual interest as it covers the provision of three lights of major importance and light power required for service on small uninhabited islands in the Persian Gulf.

The locations are such that unattended operation is essential and the lighting equipments chosen are of the AGA Dalen type.

Each light will be of the revolving type with optics of the 4th order illuminated by dissolved acetylene gas; the light source is an incandescent mantle, which upon becoming damaged in service is replaced by a new one by an automatic exchanger equipped to carry four mantles for use in succession. The acetylene gas on its way to the burner also provides the motive power for revolving the lens.

Night and day control is by the well proved AGA Sunvalve.

The first of the three lights is now ready for despatch and will be erected on Jezirat Halul in Lat. 25°42'N., Long. 52°23'E. approximately, to serve as an aid to vessels making for or departing from the Umm Said Channel and the oil terminal on the Qatar Peninsula.

The Halul light apparatus consists of a pedestal upon which is mounted a 4th order (250mm. focus) revolving lens of 3 panels set 120° apart with a 25 litre Dalen incandescent mantle at the focus. The pedestal also carries the apparatus which supplies the air-acetylene mixture to the burner, and which also revolves the lens at a speed of one revolution in 36 seconds, thus producing a flash of 0.43 duration every 12 seconds. Each flash has an apparent intensity of 78,000 standard candles resulting in a range of visibility of 29 sea miles under clear weather conditions.

There is a natural elevation at Halul of 192-ft. which together with an additional 15-ft. to the focal centre of the light provides a geographical range of 21 sea miles when observed from 15-ft. above sea level.

Lantern House with revolving pedestal and optic.

The light apparatus described above is housed within a lantern with cupola roof and the complete assembly is depicted in the accompanying photograph. The design of the lantern is the normal AGA standard whereby a constant balance of air pressure is maintained irrespective of prevailing weather conditions. To withstand corrosion all components with the exception of the murette are of non-ferrous metal.

The lantern will be mounted on a reinforced concrete substructure in which the 15 gas accumulators will be housed.

The next of the three lights to be despatched is to replace the existing low powered beacon on Jezirat Kubbar, a small sandy islet with an elevation of only 10-ft. in position Lat. 29°05'N., Long. 48°30'E., approximately. The light here is to serve as an aid to vessels leaving the main route up to the Persian Gulf and making for Kuwait and the oil loading point at Mena Al Ahmedi in the Sheikdom of Kuwait.

Because of the lack of natural elevation at this site the lantern will be mounted on a steel tower 75-ft. in height. The specially designed tower for this light and also that for the third light at Jezirat Kubbar are shown in the second photograph. The use of this tower will give the light a total elevation of 90-ft., and to an observer at 15-ft. above sea level a geographical range of 15 miles.

Specially designed towers each 75-ft. in height.

The revolving light in this instance will provide a group flash (2) every 10 seconds. The optic is 4th order (250mm. focus) with 4 panels, and with a 25 litre mantle at the focus the flashes each of 0.24 seconds duration will have an apparent intensity of 46,000 standard candles, resulting in an optical range of 26½ sea miles in clear weather. The complete light character will be 0.24 second light plus 2.26 seconds eclipse plus 0.24 second light plus 7.26 seconds eclipse.

The battery of 15 gas accumulators will be accommodated in a steel housing at the base of the tower.

The third light is destined to replace the small AGA beacon already established on Jezirat Farsi, a small sandy islet, again with an elevation of only 10-ft., in position Lat. 27°59'N., Long. 50°11'E., approximately, on the main shipping route up the Persian Gulf to ports such as Basra, Abadan, Kuwait and Bandar Shapur.

Mounted on a 75-ft. tower the lighting equipment and character is similar to that for Jezirat Halul.

Whilst the geographical range is 15 sea miles, the optical range is some 29 sea miles in clear weather, and the additional power is provided in this instance to counter the reduction in visibility due to sand and dust haze conditions which are more prevalent at the northern end than elsewhere in the Persian Gulf.

Timbers of South America.

The Timber Development Association have recently issued a revised edition of the red booklet "Timber of South America." Since this booklet was first published, fresh information as to the properties and uses of South American timbers has been received by the Association and this has been incorporated in the revised edition. The booklet covers 93 timbers giving details of common and other names, general description, working qualities, seasoning, strength and uses in most instances. A full index of common and botanical names has been included together with a use guide which should be of great assistance to all handling these woods.

Copies of this new booklet can be obtained on application to the Timber Development Association, 21, College Hill, London.

Diving Equipment and Appliances

1. Gear Used in Dock, Harbour and In-Shore Work

(Specially Contributed)

IN an article entitled "Diving Methods and Appliances" by Commander R. Walker, R.N.R., which appeared in the March 1951 issue of this Journal, a general survey was given of the work which can be performed by divers in the conditions normally encountered in dock, harbour and in-shore work. It is now proposed to supplement that article with a series devoted to the description of various types of diving gear and appliances, used for underwater engineering and repair work, with their advantages and limitations, so that readers may have a wider knowledge of the manufacturing facilities and experience upon which they can draw when the need arises.

The series will be divided into three sections as follows:
(1) Diving Gear for Use in Shallow Waters.
(2) Underwater Welding and Repair Technique.
(3) Apparatus Used in Underwater Engineering and Photography.

As this article is only concerned with comparatively shallow water diving in harbours and docks, it is not proposed to describe the apparatus used for deeper diving, in the open seas, which is also manufactured by these firms.

Rigid Helmet and Flexible Dress Gear.

There is no doubt that the vast majority of underwater works go forward on the basis of divers using standard rigid helmet and flexible dress gear, with the usual air line supply, although this equipment has the disadvantage of considerable bulk and weight. At the same time, it must be admitted that no alternative methods of diving give the same capacity for prolonged work under water, with the diving party so free from the interruptions and anxieties that attend the use of various alternatives, involving compressed gas bottles, special valves and close watch on diving spells to ensure that the return to the surface is made before bottle pressures drop too low. Standard gear is hard wearing, reliable, and needs comparatively little maintenance. In shallow water, the diver can remain submerged for long periods if necessary. The fact that so much hand work and craftsmanship goes into the production of the equipment, guarantees the personal care of the workmen, which is so essential where divers' lives are at stake.

Helmets and Corselets.

In standard gear the variety of helmets is quite considerable. These can be obtained with corselets to fit either 12-bolt square, 12-bolt round or Admiralty type 6-bolt dresses. From time to time 3-bolt Continental type equipment is supplied, but not often for use in this country.

For those who are unfamiliar with the manufacture of diving helmets the following notes are interesting.

Starting from a copper spinning, the head is built up with gun-metal fittings for the neck ring, windows, inlet and outlet valves etc., which are sweated on with the copper head cut and bent into recesses in the gun-metal fittings so that an extremely powerful joint is obtained. When all the metal fixtures are thus attached, the whole head is electro-tinned. This prevents the formation of gangrene for a considerable period of use.

The corselets are gun-metal castings, with the corselet bands fitted to a standard jig, so that the bands from one corselet will always fit another in an emergency. All other fittings are made in the same way, to standard sizes and threads, so that any helmet head will fit any corselet of the same type, and the screw-in front windows are also interchangeable.

Quick-acting and slow-acting outlet valves are available at the user's choice, with or without external spindles or internal knock-valves.

To combine the advantages of standard equipment, from the safety and ease of working point of view, with the lightness so often found with self-contained bottle-breathing gear, work has been going on for some time to produce a lightweight, quick-entry, air line helmet and dress. This has recently been tested, and found to be extremely comfortable, with very good helmet vision, and a really simple neck-entry joint for helmet and dress. That it is light when out of the water, and easy to handle when submerged is vouched for by the fact that, last year, a lady only about 8 stone in weight, dived successfully in a testing tank, and remained for some while underwater without strain when fully equipped.

The general aim has been to produce, in lighter-than-usual form, all that a diver needs to be able to go down, for periods of two to three hours if required, and undertake, in greater comfort and flexibility, such work as welding, cutting, charge-laying and so on, where bulky standard gear is sometimes a disadvantage. This gear should also suit those who wish to be able to make an occasional "dip" for survey and inspection work. With a small trailer to take a portable compressor set, all the equipment, including telephone gear, can be taken easily in an average 10-12 h.p. car.

The original helmet and corselet were of the twelve-bolt type and this is still used by some divers today. In this, the rubber collar at the top of the diving dress has 12 bolt-holes corresponding with 12 screws on the corselet, or breastplate, the collar being clamped between the corselet and 4 metal straps, screwed by 12 nuts. The lower part of the helmet and the upper part of the corselet are fitted with segmented rings for quick attachment by one-eighth of a turn, a similar system being used with most other types of helmets.

Some years ago the 6-bolt helmet was adopted by the Royal Navy and some other Navies. This was designed as an efficient compromise between the 12-bolt type and the no bolt and 3-bolt types favoured by some foreign divers. The latter types with small rubber collars clamped between the helmet and the top of the corselet have a smaller watertight joint, but are not easy to put on owing to the narrow entry which needs considerable stretching. The 6-bolt helmet whilst giving the same convenient size entry to the dress as the 12-bolt, halves the number of parts to be adjusted. Two metal clamping straps are used, each having three recesses on the underside. The straps fit over 6 metal screws on the corselet and the 6 recesses fit exactly to 6 ribs on the rubber collar of the dress. The clamping straps are screwed down with metal nuts, firmly securing the corselet to the dress so that it is watertight. Two-bolt and 8-bolt helmets fitted with various patterns of windows are also made.

The inlet valve at the back of the helmet is of the non-return type and in the event of damage to pump or air hose, the diver can, by closing his outlet valve, retain sufficient air in his dress to enable him to reach the surface safely.

Outlet valves are also non-return and of various designs. Some are fitted with a spindle which, on being pressed in with the finger, closes the valve immediately. In others the spindle is extended inwards, terminating in a metal disc which can be operated by pressure of the side of the diver's head, thus leaving both hands free.

Dresses.

The rubber and tanned twill dresses are made with 3 grades of twill; heavy, medium and light. The first stands up best to hard work and rubbing against rocks and barnacles, while the last is more supple and comfortable to wear. Three standard sizes of dress are made—large, medium and small. The outer collar of any dress of a given type will fit any helmet—corselet of the same number of bolts.

Dresses for the no-bolt and 3-bolt type of helmet are made with smaller rubber collars to clamp between the helmet and top of the corselet.

Diving Equipment and Appliances—continued

These dresses are built to the highest standard of workmanship, and are in use all over the world. Special requirements, such as extra-large or extra-small sizes, customer's extra reinforcement needs and similar departures from standard specifications, can be met without any difficulty.

A point that should be stressed is that users should give some thought to the conditions in which the divers will be working so as to choose appropriate dresses. Unvulcanised dresses are certainly more flexible, but have the disadvantage that the seams will disintegrate quickly in oily conditions, whereas vulcanised dresses will stand up far better to oil contamination, even though being vulcanised does make them take a little longer to work in to flexibility. Comments on the storage of dresses are worth repeating too, the main essential being that before being stored, dresses should be cleaned off by scrubbing with soapy water, thoroughly dried out, and then kept in a dark store, not exposed to extremes of heat and cold. They also should be unfolded from time to time to prevent the rubber setting in creases.

Experimental suits have been made using Neoprene, a synthetic rubber consisting principally of polymerised chloroprene, for which is claimed greater resistance to heat than natural rubber, resistance to oils and most chemicals, and greater durability.

Lightweight Diving Apparatus.

A type of apparatus, less cumbersome than the standard type, is the "Demand Valve" apparatus. With this, a lightweight dress with a partial rubber hood for the head and a separate facemask (with mouthpiece and noseclip) are worn. Either weighted boots or rubber "swim-fins" of the "frogmen" type can be worn on the feet, depending on the nature of the work to be carried out. In warm water the apparatus can be worn with bathing trunks only.

Air supply from the surface is either from (1) Cylinders of compressed air or (2) an air compressor. In the case of (1) a cylinder of 100 cubic feet capacity will last about $\frac{1}{2}$ an hour at a depth of 100 feet if the diver is doing light work, and correspondingly longer at lesser depths. Where an air compressor is used an air reservoir must be provided.

The demand valve (controlled by the diver's respirations) and the outlet valve are carried high up on the diver's back and are connected to the facemask by separate flexible tubes.

Another type suitable in depths up to about 30 feet is that supplied with air from the surface by means of a small lever-type hand pump. A two-piece suit with full facemask and special mouthpiece are worn, and a small neck-type breathing bag is used.

A further example is a new lightweight transportable set. Although this is powered by an air-cooled petrol engine, driving an air-cooled compressor, hours of diving can be carried out without divers being handicapped by foul air supply.

A useful feature of this set is that it can be easily transported by air. This is not so important, perhaps, in this country, but it is of some importance in export markets, where distances for transport are very great. In a few minutes the whole set, engine, compressor, filter, air receiver and wheels can be dismembered into parts, and quite easily man-handled into a small plane. Steady work can be undertaken with this compressor, as it can easily maintain a diver for hours on end, at depths up to 70-80 feet and has sufficient output to supply two or three divers in shallow water.

Air Hose and Couplings.

These, of course, are of vital importance to the diver. All hose is specially tested before issue to a much higher pressure than that required for normal work. It must be quite flexible and, at the same time, free from any tendency to flatten when bent over a sharp edge or nipped under something heavy.

Air hose capable of withstanding pressures of nearly 1,000 lbs. per square inch without bursting or displacing couplings, and to withstand 1,000 lbs. pull without destructive damage is supplied in lengths of 30, 45, 50 and 60 feet; each length having a screw connection at either end. Where a deep dive is necessary several lengths are connected together. Various types of couplings are made for this purpose.

[Photo courtesy of Siebe Gorman & Co., Ltd.

(Left) Front View Standard Diving Dress; (Right) Side View of Shallow Water Self-contained Diving Suit.

A recent improvement is the development of a manufacturing process, which ensures that hose will not rotate down its length under pressure. This is an important matter when several lengths of hose are needed, where a diver is working some distance from the air supply, or in considerable depth. Cases have been known where a latent twist of as many as eighteen complete turns has existed in six fifty-foot lengths of hose when coupled up.

All the usual ancillary equipment such as boots, weights, belts etc. can be obtained without difficulty.

Divers' Telephones.

As a result of war time development, the old system of diver's telephone has been superseded by an amplifying telecommunication system, in which the diver has a small two-way microphone installed in his helmet, and his life-line is replaced by a rope, exactly similar in feel and appearance, but with the leads for the telephone laid in the centre of each of the three strands of the rope. The deck end of this rope is coupled up to the amplifying set, which can be arranged for two divers to work independently of each other with the conversation overhead on deck. These developments do away with the old-fashioned earphones on the diver's head, and also enable all the diving party to hear the diver's comments.

Since the introduction of the first diver's telephone many years ago, considerable advance has been made in the means of communication with the diver. One of the latest equipments is the Loudspeaking Thermionic Telephone Mark IV (for 2 divers) and Mark V (for 1 diver).

The Mark IV gives a complete 3-way communication by means of simple switching and enables the following to be carried out immediately:

(1) Surface attendant to speak to diver submerged at any working depth.

(2) Diver to speak to surface attendant.

(3) Surface attendant to speak to 2 divers simultaneously.

Diving Equipment and Appliances—continued

(4) Intercommunication between 2 divers with surface attendant listening. Speech between divers is controlled by means of "chin-pushes" in the divers' helmets which actuate relays at the surface. The surface attendant can interject to either or both divers if necessary.

The Mark V is similar in principle but, being for one diver only, is controlled at the surface by a single "Listen-Speak" switch.

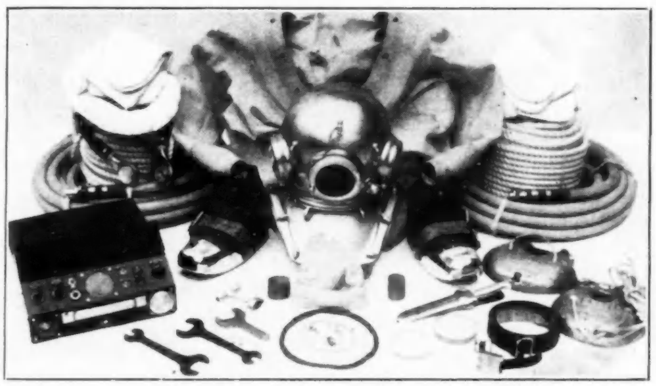
Headphones and carbon microphones are dispensed with in both types and a specially designed all-metal, transmitter-receiver, is located in the upper part of the diver's helmet, giving more than adequate volume to overcome air and helmet noises. Reception at the surface is such that it is audible some distance from the instrument. The equipment is light, robust, and compact, and is used with the standard telephone breastrope.

Within a few weeks interesting tests of an improved type of telephone are taking place. To meet very exacting service conditions, changes of a radical nature have been made to the present case, fitting and circuit. These changes have produced a foolproof, shock-proof, splash-proof set, which it is claimed will be one of the most suitable equipments in the world for normal diving work.

Air Supply—Pumps and Compressors.

The manually worked air pump is still in general use, particularly for diving at the lesser depths, and where man power is not a major consideration. Electrically or petrol-driven pumps for alternative working by hand if necessary, are also manufactured.

The use of electric, petrol or diesel-driven compressors, instead of pumps, is becoming more common for present day diving operations of a prolonged nature, and where more than one diver is employed. The initial and running costs are soon offset by the saving of labour costs necessary with hand pumps.



[Photo courtesy of C. E. Heinke & Co., Ltd.
Layout of Typical Standard Diving Equipment.

In the manufacture of compressors the following salient points are given full effect:

(1) The air supply must be filtered to remove any possible impurities so that it is clean and fresh, and it must be delivered through an efficient control valve.

(2) The air must be delivered through a reservoir of sufficient capacity to ensure that, should there be a stoppage of the compressor, there is enough reserve air to bring the diver or divers to the surface in safety.

Various types of compressors are made to suit particular conditions. For example, a very handy set is the petrol-driven, portable air-compressor, which is suitable for 2 divers to a maximum depth of 100 feet or 1 diver to 200 feet. This set is mounted on rubber wheels and with its horizontal air-reservoir is compact and easily transportable.

Steam-driven compressors are also made, as are Diesel-driven combined boat-propelling and air compressing sets.

A third system of supplying air to divers, where, under certain conditions, it may be advantageous to dispense with pumps or compressors, is to supply air from high-pressure cylinders (1,800 lbs. or more) or previously charged torpedo air reservoirs. Here again special precautions must be taken to ensure that only clean and fresh air is employed.

Self-contained Diving Apparatus.

Although the greater part of normal diving work in docks, harbours etc., is carried out with surface air-supply apparatus, there are occasions in intricate places where freedom from an air-pipe is an advantage, or when mobility and manœuvrability is important for short dives in shallow water. Under these circumstances, self-contained apparatus has advantages. The first apparatus of this type was introduced over 70 years ago, and the principle used then, still stands to the present day. This principle is the regeneration of the divers' exhaled breath being passed though a chemical CO_2 absorbent, and replenished with oxygen (or a mixture of oxygen and nitrogen) from a cylinder or cylinders of the compressed gas carried on the diver. Owing to the effect of oxygen under pressure, it must be remembered that pure oxygen must not be breathed at depths greater than 30 feet.

A useful self-contained apparatus is the compressed air type. This does not work on the regenerative principle and the diver's exhaled air is vented into the water. Its diving duration depends, therefore, on the depth of water and the amount of exertion of the diver. It is worn with either a one-piece or two-piece suit or, in warm water, with bathing trunks. Either boots or "swim-fins" can be worn.

Divers' Lamps.

Fixed electric flood lamps supplied with current from the surface, or portable lamps with dry batteries, or with surface current supply, are used according to the nature of the work to be done. The fixed lamps are intended to be slung over the job out of the divers' way.

Flood lamps include tungsten types (with or without reflector) with a range of bulb from 200 to 3,000 candle-power and a 3 x 45-watt sodium flood lamp of the well glass type.

In turbid water it is found that ultra-bright light sources are not so effective as sodium with its rich, golden light and high luminous efficiency. The weight of the sodium flood lamp is 38 lbs., excluding cable, and its dimensions are 22-in. in length by 8½-in. diameter. For supplying this lamp a mains unit is made, housing 3 leak transformers and capacitor for power factor correction. Should A.C. mains not be available, a petrol-driven alternator set is used. This weighs 101 lbs., is compact and easily transportable.

A 45-watt sodium handlamp and a 250-watt mercury vapour handlamp both with surface current supply, are also manufactured. These weigh 6¾ lbs. and 30 lbs. respectively.

Self-contained battery-type handlamps and torches (with or without switch are useful for close examination work, such as the repair of underwater masonry etc.

It should be remembered by users of all types of underwater lamps that they must be submerged before switching on, in order to prevent the glass, when heated, from being cracked by the plunge into cold water. They must also be switched off before being taken out of the water.

(to be continued)

Hudson River Channel Deepening.

Deepening of the Hudson River channel between New York and Albany, N.Y., to a depth of 32-ft. has been approved by the U.S. Army Corps of Engineers. This move would enable the waterway to pass merchant shipping constructed during the 1939-1945 war. The present channel is 27-ft. and the cost of the deepening project is estimated at 26.7 million dollars. Progress now depends upon the appropriation of funds by Congress; the port authority originally asked for a 35-ft. channel. The project includes a turning basin at the upper end of the channel and two anchorages, at Hudson and Stuyvesant.

Fig. 1 (left). G.E.C. lanterns and new brackets mounted on columns remaining from the pre-war lighting installation in the Singapore docks.

Fig. 2 (right). Night view of wharf lighting in front of new godowns.

Dock Lighting at the Port of Singapore

Completion of Rehabilitation Scheme

Among the reconstruction and improvement works undertaken by the Singapore Harbour Board after the war, lighting was given high priority. The installation of an efficient system of dock lighting was imperative, as very little of the previous equipment remained at the end of the Japanese occupation, and the amount of pilfering that went on in the docks at that time made it necessary that immediate steps should be taken to effect an improvement. The work, which has recently been completed, has extended over several years and was planned to keep pace with the erection of new buildings in the dock area.

All the main lighting is by means of 400-w. mercury lamps in G.E.C. lanterns with bowl difractors. New top brackets were made for the lattice stool standards of the previous installation, giving a mounting height for the lanterns of approximately 30-ft. On the wharf itself, these standards were spaced about 200-ft. apart so that there is one at each end of all the godowns remaining from the pre-war installation. Several new godowns have been built, and for these pipe brackets attached to the godown eaves have been provided for mounting the lanterns. The new godowns are about 340-ft. long, so that three brackets are mounted on each, with a spacing of about 175-ft., one being at each end and one in the centre. The height of the lanterns above the wharf is about 25-ft.

Fig. 3. Roadway and localised lighting at rear of godowns.

There are approach lanes to the wharf between each block of godowns, and all brackets at the ends of the buildings, both on the lattice posts and on the godowns themselves, are at an angle of 45° to the wharf so that the lanterns serve the approach lanes as well as the wharf area.

In the general roadways behind the blocks of godowns, the lanterns are mounted on pre-war lattice standards at about 30-ft. above road level with a spacing of approximately 220-ft. The roadways average 75-ft. in width, and the only additional lighting in this area comes from tungsten lamps in 18-in. R.L.M. reflectors, mounted under the godown eaves immediately over the doorways, to supplement the light from the roadway lanterns.

All the lighting equipment was supplied through the Singapore Branch of the General Electric Co., Ltd., which collaborated in the installation with the Electrical Department of the Singapore Harbour Board under the direction of its Electrical Engineer, Mr. Robert Earl.

Notice of Dock Accidents

By GEO. B. LISSENDEN, M.Inst.T.

Several well-known stevedoring firms in the United Kingdom have asked the writer to set down in convenient form, for the ready reference of those who are engaged in the loading and unloading of ships, the legal obligations with respect to the gear used in the process, and then say what the law prescribes if, notwithstanding all the precautions that are taken to ensure safe working, an accident happens.

What the Law Prescribes

To ensure that the gear used in cargo-handling is in a fit and proper condition, Part III of the Docks Regulations 1934—otherwise known as Statutory Rule and Order 1934, No. 279—prescribes as follows:—

18.—(a) " All **lifting machinery** shall have been tested and examined by a competent person in the manner set out in the Schedule to these Regulations before being taken into use.

(b) (i) " All derricks and permanent attachments, including bridle chains, to the derrick, mast and deck, used in hoisting or lowering shall be inspected once in every twelve months and be thoroughly examined once at least in every four years.

(ii) " All other **lifting machinery** shall be thoroughly examined once at least every twelve months.

(iii) " For the purposes of this Regulation thorough examination means a visual examination, supplemented if necessary by other means such as a hammer test, carried out as carefully as the conditions permit, in order to arrive at a reliable conclusion as to the safety of the parts examined; and if necessary for the purpose, parts of the machines and gear must be dismantled.

19.—(a) " No chain, ring, hook, shackle, swivel or **pulley block** shall be used in hoisting or lowering unless it has been tested and examined by a competent person in the manner set out in the Schedule to these Regulations.

(b) " All chains, other than bridle chains attached to derricks or masts, and all rings, hooks, shackles and swivels used in hoisting or lowering shall, unless they have been subjected to such other treatment as may be **prescribed,** be effectually annealed under the supervision of a competent person and at the following intervals:—

(i) " half-inch and smaller chains, rings, hooks, shackles and swivels in general use, once at least in every six months.

(ii) " all other chains, rings, hooks, shackles and swivels in general use once at least in every twelve months.

" Provided that in the case of such gear used solely on cranes and other hoisting appliances worked by hand, twelve months shall be substituted for six months in paragraph (i) and two years for twelve months in paragraph (ii).

" Provided also that where the Chief Inspector of Factories is of opinion that, owing to the size, design, material or infrequency

Notice of Dock Accidents—continued

of use of any such gear or class of such gear, the requirement of this Regulation as to annealing is not necessary for the protection of **persons employed,** he may by certificate in writing (which he may in his discretion revoke) exempt such gear or class of gear from such requirement subject to such conditions as may be specified in such certificate.

(c) "All chains, other than bridle chains attached to derricks or masts, and all rings, hooks, shackles, swivels and **pulley blocks** shall be inspected by a competent person immediately before each occasion on which they are used in hoisting or lowering, unless they have been inspected within the preceding three months.

(d) "All chains, rings, hooks, shackles or swivels used in hoisting or lowering which have been lengthened, altered or repaired by welding shall before being again taken into use be adequately tested and re-examined.

20.—(a) "No rope shall be used in hoisting or lowering unless:

(i) "it is of suitable quality and free from patent defect, and

(ii) "in the case of wire rope, it has been examined and tested by a competent person in the manner set out in the Schedule to these Regulations.

(b) "Every wire rope in general use for hoisting or lowering shall be inspected by a competent person once at least in every three months, provided that after any wire has broken in such rope it shall be inspected once at least in every month.

(c) "No wire rope shall be used in hoisting or lowering if in any length of eight diameters the total number of visible broken wires exceeds ten per cent. of the total number of wires, or the rope shows signs of excessive wear, corrosion or other defect which, in the opinion of the person who inspects it, renders it unfit for use.

(d) "A thimble or loop splice made in any wire rope shall have at least three tucks with a whole strand of the rope and two tucks with one half of the wire cut out of each strand. The strands in all cases shall be tucked against the lay of the rope. Provided that this Regulation shall not operate to prevent the use of another form of splice which can be shown to be as efficient as that laid down in this Regulation.

21.—"For the purposes of Regulations 18, 19 and 20, a person shall not be deemed to be a competent person if and in so far as the Chief Inspector has given notice in writing that such person is in his opinion not technically qualified to carry out the tests, examinations or annealing required by these Regulations.

"Provided that any person whom the Chief Inspector may thus declare not to be competent shall have the right to appeal against such declaration to the Secretary of State, whose decision shall be final.

22.—(a) "Certificates in the **prescribed** forms and containing the **prescribed** particulars with regard to the tests, examinations, inspections, annealing or other treatment required under Regulations 18, 19 (a) and (b) and 20 (a) shall be obtained, and entered in or attached to the **prescribed** register before the machinery, chain, rope or other gear to which the certificate refers is subsequently taken into use in connection with the **processes.**

(b) "The **prescribed** register with the certificates required to be attached to it shall be kept on the premises unless some other place has been approved in writing by the Chief Inspector.

23.—"No **pulley block** shall be used in hoisting or lowering unless the safe working load is clearly stamped upon it.

24.—"Means shall be provided to enable any person using a chain or wire rope sling to ascertain the safe working load for such chain or sling under such conditions as it may be used.

(a) "As regards chain slings, such means shall consist of marking the safe working load in plain figures or letters upon the sling or upon a tablet or ring of durable material attached securely thereto.

(b) "As regards wire rope slings, such means shall consist of either the means specified in paragraph (a) above or a notice or notices, so exhibited as to be easily read by any person concerned, stating the safe working loads for the various sizes of wire rope slings used.

25.—"Chains shall not be shortened by tying knots in them; and suitable packing shall be provided to prevent the links coming into contact with sharp edges of loads of hard material.

26.—"All motors, cog-wheels, chain and friction gearing, shafting, live electric conductors and steam pipes shall (unless it can be shown that by their position and construction they are equally safe to every **person employed** as they would be if securely fenced) be securely fenced so far as is practicable without impeding the safe working of the ship and without infringing any requirement of the Board of Trade.

27.—"Cranes and winches shall be provided with such means as will reduce to a minimum the risk of the accidental descent of a load while being raised or lowered; in particular, the lever controlling the link motion reversing gear of a crane or winch shall be provided with a suitable spring or other locking arrangement.

28.—"The driver's platform on every crane or tip driven by mechanical power shall be securely fenced and shall be provided with safe means of access. In particular, where access is by a ladder:

(a) "the sides of the ladder shall extend to a reasonable distance beyond the platform or some other suitable handhold shall be provided;

(b) "the landing place on the platform shall be maintained free from obstruction;

(c) "in cases where the ladder is vertical and exceeds 30-ft. in height, a resting place shall be provided approximately mid-way between the platform and the foot of the ladder.

29.—"Every crane and derrick shall have the safe working load plainly marked upon it, and every shore crane if so constructed that the safe working load may be varied by the raising or lowering of the jib or otherwise, shall have attached to it an automatic indicator of safe working loads, provided that, in cases where the jib may be raised or lowered, provision on the crane of a table showing the safe working loads at the corresponding inclinations or radii of the jib shall be considered sufficient compliance.

30.—"Adequate measures shall be taken to prevent exhaust steam from, and so far as is practicable live steam to, any crane or winch obscuring any part of the decks, gangways, stages, wharf, or quay where any person is employed in the **processes.**

31.—"Appropriate measures shall be taken to prevent the foot of a derrick being accidentally lifted out of its socket or support."

The manner of test and examination **before** taking lifting and gear into use is set out in the "Schedule" to the aforesaid Docks Regulations 1934, but this is more for the information and guidance of the engineer than the stevedore as such.

When an Accident Happens

In the Dangerous Occurrences Notification Order, 1928 (commonly known as Statutory Rule and Order 1928, No. 876), the Secretary of State decreed that:

"In pursuance of Section 5 of the Notice of Accidents Act, 1906, I hereby extend the provisions of the said Act requiring notice of accidents in factories and workshops to be given to an Inspector, to the following classes of occurrences in a factory or workshop (including any place which, for the purpose of the provisions of the Factory and Workshop Act, 1901, (a) with respect to accidents in a factory or workshop, or is included in the word factory or workshop, or in part of a factory or workshop) whether personal injury or disablement is caused or not:

"All cases of :

I. "bursting of a revolving vessel, wheel, grindstone or grinding wheel moved by mechanical power;

II. "breaking of a rope, chain, or other appliances used in raising or lowering persons or goods by aid of mechanical power;

III. "explosion or fire causing damage to the structure of any room or place in which persons are employed, or to any machine or plant contained therein, and resulting in the complete suspension of ordinary work in such room or place or stoppage of machinery or plant for not less than five hours, where such explosion or fire is due to (i) the ignition of dust, gas or vapour, or (ii) the ignition of celluloid, or substances composed wholly or in part of celluloid or (iii) electrical short circuit, or failure of electrical apparatus;

IV. "explosion or fire not included in paragraph III affecting any room in which persons are employed and causing complete suspension of ordinary work therein for not less than 24 hours."

Notice of Dock Accidents—continued

Every stevedore knows that no matter how careful he may be in the selection of his gear, and the men whom he employs, an accident is almost bound to happen, sooner or later—due to an undiscovered flaw somewhere or the foolhardiness of someone.

From the foregoing it will be seen that in any such event the wise and proper thing to do is to notify the Factory Inspector immediately, and give him the opportunity to enquire into the facts of the case at the earliest possible moment.

Slow Turn-Round of Shipping

British Chamber of Commerce Letter to Minister

Serious difficulties still being encountered in consequence of the slow turn-round of ships in United Kingdom ports, are referred to in a letter which has been sent to Lord Leathers, Secretary of State for Co-ordination of Transport, Fuel anl Power, by the Association of British Chambers of Commerce.

The full text of the letter, which was signed by Mr. A. H. S. Hinchliffe, president of the association, is as follows:

"I am desired by my executive council to re-emphasise its growing concern over the serious difficulties still encountered with the extremely slow turn-round of shipping in United Kingdom ports. We are well aware that a lot has been said and written about this in recent months. But in our view it is having such a hampering effect on our efforts to correct the serious financial and economic position of our nation that it cannot be stressed too often.

"The several causes of present difficulties are common knowledge. A Working Party set up by the previous Minister of Transport published its report and recommendations as far back as 1948. That report set forth a number of practical suggestions which, in the association's view, are capable of being given early effect. The need to pursue more vigorously every possible method for improving the position becomes even more evident when viewed together with the serious and challenging statement made by the Chancellor of the Exchequer following the reassembly of Parliament.

"Industry and commerce have continuously urged an improvement in the turn-round of shipping if growing competition in world trade is to be met. Now must be added the dire necessity of saving the entire sterling area from imminent collapse and the redoubling of efforts for maintaining and, indeed, improving the British trading position in world markets.

"Any contribution to the national benefit obtained through increased industrial productivity could be vitiated entirely by a continuance of the present shipping situation. Hence, no other single factor so seriously prejudices the nation's position as a world trading power than the growing costs and deterioration in service that is caused by the present position in United Kingdom ports.

"At a time when the prompt shipment of exports is a vital factor in the struggle to earn hard currency, our shipping space should be used to its full efficiency. Instead, this valuable exchange earning asset is being wasted by the hold-up of ships in port. This association is not insensitive to the many fears which often dominate the minds of port and dock workers. We are, however, convinced that honest and harder work, coupled with the fullest and proper use of the up-to-date equipment available, would mean higher wages and enhanced security.

"The elimination of restrictive practices and malpractices would materially assist the nation to hold its own as the era of a sellers' market declines and competition in world markets becomes keener. A perpetuation of the present position can only serve to hasten the eclipse of British pre-eminence in shipping and world trade.

"My association therefore urges that time is not on our side, and the nation cannot afford to await longer-term solutions to such acute problems. With the grave statement of the Chancellor of the Exchequer in mind, I am desired to ask that renewed efforts be made to give effect to many of the immediately practicable recommendations made by the Working Party in 1948, and that every possible step will now be taken to impress upon all port and dock interests—employers and labour alike—the greater urgency with which turn-round of shipping problems must be faced.

"The Chamber of Commerce movement is at his Majesty's Government's disposal to assist and co-operate in any practical way in bringing about an improvement in the present deplorable situation."

Co-ordination in Cargo Handling

Growing support from British and foreign shipowners, and port authorities for the aims of the International Cargo Handling Co-ordination Association, was reported at a meeting of the executive committee of the Association held recently in Antwerp.

Rear-Admiral A. L. P. Mark-Wardlaw, president of the committee, said problems connected with cargo handling in East and West African ports, and other inquiries from India, Australia and New Zealand were being followed up. Close co-operation was also anticipated with the International Chamber of Commerce, the Anglo-American Council of Productivity, Federation of British Industries and the Federation of German Shipowners, whose president would shortly be holding a meeting in Hamburg which he hoped would be attended by port authorities and other interested parties.

The first technical meeting of the Association is to be held in Rotterdam on April 21st, 22nd and 23rd, and copies of papers to be read will be circulated two weeks at least before the meeting.

The Association is also proceeding with the establishment of what is claimed to be the first library on cargo handling technique in the world. To assist in making this library as complete as possible, the firms and organisations who specialise in the manufacture of fork-lift trucks, derricks, winches, cranes and cargo handling gear of any kind are asked to send their newest literature to the Assistant Co-ordinator, 39, Wilton Road, London, S.W.1.